THE WESTERN WONDER-LAND

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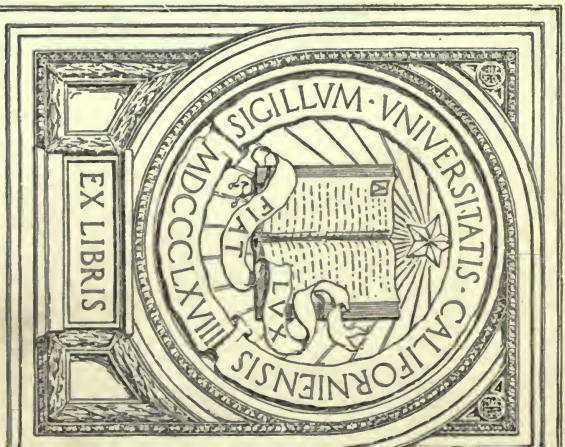

Amy H. Izon

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THE TWINS, BLUFF CITY, UTAH

The distance from the bottom of the cliff to the top of the erosion columns is 275 feet.

Frontispiece

THE WESTERN WONDER-LAND

HALF-HOURS IN THE WESTERN UNITED STATES

BY

HAROLD WELLMAN FAIRBANKS, PH.D.

1860.

LONDON

D. C. HEATH & COMPANY

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THE WESTERN WONDER-LAND

THE WORK OF THE COLORADO RIVER

THE Colorado River is not old, as we estimate the age of rivers. It was born when the Rocky Mountains were first uplifted to the sky, when their lofty peaks, collecting the moisture of the storms, sent streams dashing down to the plains below. Upon the western slope of the mountains a number of these streams united in one great river, which wound here and there, seeking the easiest route across the plateau to the Gulf of California.

At first the banks of the river were low, and its course was easily turned one way or another. From the base of the mountains to the level of the ocean there is a fall of more than a mile, so that the river ran swiftly and was not long in making for itself a definite channel.

Many thousands of years passed. America was discovered. The Spaniards conquered Mexico and sent expeditions northward in search of the cities of Cibola, where it was said that gold and silver were abundant. One of these parties is reported to have reached a mighty cañon, into which it was impossible to descend. The cañon was so deep that rocks standing in the bottom, which were in reality higher than the Seville cathedral, appeared no taller than a man.

Another party discovered the mouth of the river and called it, because of their safe arrival, The River of Our Lady of Safe Conduct. They went as far up the river as its shallow waters would permit, but failed to find the seven cities of which they were in search, and turned about and went back to Mexico. For years afterward the river remained undisturbed, so far as white men were concerned. A great part of the stream was unknown even to the Indians, for the barren plateaus upon either side offered no inducements to approach.

Trappers and explorers in the Rocky Mountains reached the head waters of the river nearly one hundred years ago, and followed the converging branches down as far as they dared toward the dark and forbidding cañons. It was believed that no boat could pass through the cañons, and that once launched upon those turbid waters, the adventurer would never be able to return.

The Colorado remained a river of mystery for nearly three centuries after its discovery. When California and New Mexico had become a part of the Union, about the middle of the last century, the cañon of the Colorado was approached at various points by government exploring parties, which brought back more definite reports concerning the rugged gorge through which the river flows.

In 1869 Major Powell, at the head of a small party, undertook the dangerous trip through the cañon by boat. After enduring great hardships for a number of weeks, the party succeeded in reaching the lower end of the cañon. Major Powell's exploit has been repeated by only one other company, and some members of this party perished before the dangerous feat was accomplished.

FIG. 1.—THE GRAND CAÑON OF THE COLORADO
The work of a river

The Colorado is a wonderful stream. It is fed by the perpetual snows of the Rocky Mountains. For some distance the tributary streams flow through fertile valleys, many of them now richly and widely cultivated. But soon the branches unite in one mighty river which, seeming to shun life and sunlight, buries itself so deeply in the great plateau that the traveller through this region may perish in sight of its waters without being able to descend far enough to reach them. After passing through one hundred miles of cañon, the river emerges upon a desert region, where the rainfall is so slight that curious and unusual forms of plants and animals have been developed, forms which are adapted to withstand the almost perpetual sunshine and scorching heat of summer.

Below the Grand Cañon the river traverses an open valley, where the bottom lands support a few Indians who raise corn, squashes, and other vegetables. At the Needles the river is hidden for a short time within cañon walls, but beyond Yuma the valley widens, and the stream enters upon vast plains over which it flows to its mouth in the Gulf of California.

No portion of the river is well adapted to navigation. Below the cañon the channels are shallow and ever changing. At the mouth, enormous tides sweep with swift currents over the shallows and produce foam-decked waves known as the "bore."

Visit the Colorado River whenever you will, at flood time in early summer, or in the fall and winter when the waters are lowest, you will always find it deeply discolored. The name "Colorado" signifies red, and was given to the river by the Spaniards. Watch the current and note how it boils and seethes. It seems to be thick with mud. The

bars are almost of the same color as the water and are continually changing. Here a low alluvial bank is being washed away, there a broad flat is forming. With the exception of the Rio Grande in New Mexico, and the Gila, which joins the Colorado at Yuma, no other river is known to be so laden with silt. No other river is so rapidly removing the highlands through which it flows.

FIG. 2.—LOOKING DOWN THE COLORADO RIVER FROM ABOVE THE NEEDLES

Over a large portion of the watershed of the Colorado the rainfall is light. This fact might lead one to think that upon its slopes the work of erosion would go on more slowly than where the rainfall is heavy. This would, however, be a wrong conclusion, for in places where there is a great deal of rain the ground becomes covered with a thick growth of vegetation which holds the soil and broken rock fragments and keeps them from being carried away.

The surface of the plateaus and lower mountain slopes in the basin of the Colorado are but little protected by vegetation. When the rain does fall in this arid region, it often comes with great violence. The barren mountain sides are quickly covered with trickling streams, which unite in muddy torrents in the gulches, carrying along mud, sand, and even boulders in their rapid course; the torrents in turn deliver a large part of their loads to the river. As the rain passes, the gulches become dry and remain so until another storm visits the region. It is storming somewhere within the basin of the Colorado much of the time, for the river drains two hundred and twenty-three thousand square miles. So it comes about that whether one visits the river in winter or summer one always finds it loaded with mud.

But what becomes of all this mud? The river cannot drop it in the narrow cañons. It is not until the river has carried its load of mud down to the region about its mouth, where the current becomes sluggish, that the heavy brown burden can be discharged. Dip up a glassful of the water near the mouth of the river, and let it settle, then carefully remove the clear water and allow the sediment in the bottom to dry. If the water in the glass was six inches deep, there will finally remain in the bottom a mass of hardened mud, which will vary in amount with the time of the year in which the experiment is performed, but will average about one-fiftieth of an inch in thickness. Each cubic foot of the water, then, must contain nearly six cubic inches of solid sediment or silt.

It has been estimated that the average flow of the Colorado River at Yuma throughout the year is eighteen thousand cubic feet of water per second. From this fact we

can calculate that there would be deposited at the mouth of the river every year, enough sediment to lie one foot deep over sixty-six square miles of territory. Nearly one three-hundredth part of the Colorado River water is silt, while in the case of the Mississippi the silt forms only one part in twenty-nine hundred.

FIG. 3.—LOOKING TOWARD THE DELTA OF THE COLORADO FROM YUMA

Now we are prepared to understand the origin of the vast lowlands about the head of the Gulf of California. Long ago this gulf extended one hundred and fifty miles farther north than it does at present, so that it reached nearly to the place where the little town of Indio now stands in the northern end of the Colorado desert.

When the Colorado River first began to flow, it emptied its waters into the gulf not far from the spot where Yuma is situated. The water was probably loaded with silt then as

it is now. Part of this sediment was dropped at the mouth of the stream, while part was spread by the currents over the bottom of the adjoining portions of the gulf. The rapidly growing delta crept southward and westward into the gulf. As fast as the sediment was built up above the reach of the tide, vegetation appeared, which, retarding the flow of the water at times of flood, aided the deposition of silt and the building up of the delta.

As the centuries went by, these lowland plains became more and more extensive, until the gulf was actually divided into two parts by the spreading of the delta across to the western shore. The portion of the gulf thus cut off from the ocean formed a salt lake fully one hundred miles in length.

We may suppose that for a long time before the barrier was high and strong, the tidal currents occasionally broke over the delta and supplied the lake with water. As the river meandered here and there over the flat delta, its channels must have undergone many changes at every time of flood. A part of the water without doubt flowed into the salt lake, and another portion into the open gulf. In fact, the basin in which the lake lay, now known as the Colorado desert, continued to receive water from the river, at intervals, until very recently. In 1891 an overflow occurred, through the channel known as New River, which flooded the lower portion of the basin and threatened to cover the railroad.

When the ocean had been permanently shut off from the head of the gulf, and the river itself had been largely diverted toward the south, the lake began to dry up. At last, most of the water disappeared and there remained a vast desert basin, at its greatest depth two hundred and

fifty feet below the level of the ocean. In the bottom of the basin a bed of salt appeared, for this substance could not be carried away, as the water had been, by the thirsty air.

Remarkably perfect beaches still exist around the shores of this old lake, and on them are found the pearly shells of multitudes of fresh-water mollusks. The presence of these shells leads us to believe that after the salt lake dried up, the river again broke in and formed a new lake of comparatively fresh water which also, after a time, dried up.

The wonderful fertility of the Colorado delta is just beginning to be appreciated. Canals have been dug to take the water from the river and distribute it over the land. Year by year the cultivated lands are being extended. The change which irrigation is making upon the surface of one of the worst deserts in the country is indeed remarkable.

The Colorado River is working on quietly and steadily. We may think, and truly, that it has already done a great work in excavating the mighty cañons along its course, but, in reality, the work already accomplished is small in comparison with that which remains to be done.

In time, if the land is not disturbed by the forces which build mountains, the plateaus through which the river now flows in such deep cañons will be carried away in the form of sand and mud. Broad valleys will replace the cañons, and the Gulf of California will become a fertile plain. As the highlands wear away the process will go on more and more slowly, for there will be less rainfall. The river will become smaller and its basin more arid. All these changes will be brought about through the crumbling of the rocks, and the removal of the waste matter by the running water.

A TRIP INTO THE GRAND CAÑON OF THE COLORADO

We may read of the Colorado plateau, and of the Grand Cañon with its precipitous walls of variously colored rock, but unless we actually visit this wonderland, it is hard to realize the height and extent of the plateau and the depth of the gashes made in its surface by running water, gashes so deep that they seem to expose the very heart of the earth.

Nature has chosen a remote and half-desert region for the location of this, the most picturesque cañon in the world, as if she wished to keep it as long as possible from the eyes of men. Once a traveller could not view the cañon without making a long and weary journey across hundreds of miles of desert; now it is quite different, for one can almost look into its depths from the windows of a palace car. But to appreciate and understand fully the stupendous work that nature has done throughout this region we must leave the cars at a somewhat distant point, and before reaching the cañon become acquainted with the country in which it lies through the old-fashioned ways of travelling on horseback or wagon.

Flagstaff was formerly the starting-point for travellers to the cañon, and we will choose it now, for the old stage road offers an interesting ride. The road first winds around that lofty snow-clad peak, the San Francisco Mountain, which can be seen from all northern Arizona. Leaving the

mountain behind, we strike out directly across the high plateau. The country is nearly level, and the open park-like forest extends in every direction as far as one can see.

It is difficult for us to believe that we are seven thousand feet above the sea, a height greater than that of the highest mountains in the United States east of the Mississippi Valley. It is this elevation, however, which brings the summer showers and makes the air cool and pleasant, for the lowlands of this portion of the United States are barren deserts, upon which the sun beats with almost savage heat.

After the rainy season green grass and an abundance of flowers appear in the open meadows scattered through the forest. But, as a rule, the entire absence of water strikes one as being very strange. Where are the springs and running streams which usually abound in mountainous regions? Throughout the whole distance of seventy miles from Flagstaff to the cañon, there are but one or two spots where water is to be found. These places are known as "water-holes"; they are simply hollows in the surface of the ground where the water collects after the showers.

There is another strange feature about the plateau over which the road leads; instead of sloping down toward the Colorado River and the Grand Cañon, the surface slowly rises, so that the little streams which are formed after the heavy rains flow away from the river.

Our journey draws to an end, but there is nothing to indicate the presence of the cañon until we get glimpses through the trees of an apparently bottomless gulf. The gulf widens upon a closer view, we reach the edge, and all its wonderful proportions burst upon us. Does the Grand Cañon look as you thought it would? Probably not, for it is unlike any other in the world. The cañon is very deep.

The river has worn its way for more than a mile down into the plateau, which once stretched unbroken from the cliffs upon which we stand, across to those upon the opposite side, nearly ten miles away.

The clear air makes objects upon the opposite side and in the bottom of the cañon seem much nearer than they really are. You may think that it is an easy task to go to the bottom of the cañon and climb back again in a day, but in reality it is so difficult an undertaking that only those who are accustomed to mountain climbing can accomplish it.

It is not merely the great width and depth of the cañon that impress us, but also the bright, variegated colors which the different rock layers display as they stretch in horizontal bands along the faces of the cliffs, or sweep around the towers and pinnacles until their detailed outlines are lost in the distant blue haze.

Our eyes wander far down, toward the bottom of the cañon, following the alternate lines of precipitous cliffs and slopes covered with rock fragments. The cliffs and slopes succeed each other like the steps in a giant stairway, until at the very bottom the opposite walls meet in a gorge so narrow that in only a few places does the river come into view, glistening like a silver thread.

A hotel stands among the trees a short distance from the brink of the cañon. Living here is expensive, for every article of food has to be brought upon the cars and wagons for a distance of hundreds of miles. Even the water has to be brought in wagons from a distant spring.

In visiting the cañon we have the choice of going on horseback or on foot. While the latter method is

much harder, yet one feels safer upon his own feet while moving along the steep and narrow trail. Our start is

FIG. 4. — A SCENE ON THE TRAIL

made in the cool air of the early morning. Leaving the top of the plateau, where among the pines the summer air is seldom sultry, and the winters are cold and snowy, we

descend, until, by luncheon time, we are far below the heights and in the midst of an almost tropical climate. This difference in climatic features between the top and bottom of the cañon is equal to the change which the traveller experiences in a trip from the pine forests of the northern United States to the cactus-covered plains of Arizona.

As we look down from the top of the trail it does not seem possible to pass the great cliffs below, and yet there must be a way, since others have gone before us. All that we have to do is simply to follow the beaten path. Nature has conveniently left narrow shelves, crevices, and less precipitous slopes here and there, which need only the application of the pick and shovel to be made passable even for pack animals. Where the trail winds into shady recesses, we find stunted fir and pine trees clinging to the crevices and stretching their roots down into the waste rock collected upon projecting ledges.

Down, down we go. The belt of the yellow pine and fir is left behind, and we come to the habitat of the piñon pine and juniper. These two will flourish where there is less moisture than is needed by the trees which grow nearer the top. Soon the trees have all disappeared and such plants as the greasewood, cactus, and agave take their place. Here, if it were not for the walls of rock rising on every hand, we might imagine ourselves upon one of the desert plains of Arizona.

New views open at every turn in the trail, as it winds along the narrow shelves of rock with precipitous walls above and below. Now it zigzags back and forth down a gentle slope, but is soon stopped by another precipice. In one place, to escape a rocky point, the trail has been

FIG. 5.—CLIFFS ON THE TRAIL INTO THE GRAND CAÑON

carried around the face of a cliff on a sort of shelf made of logs. It then passes through a crevice formed by the splitting away of a huge piece of the wall. In many places

the grade is so steep that the trail is made practically a stairway, for the steps are necessary to keep animals from slipping.

Step by step we descend until the slope becomes more gentle and a sort of terrace is reached, where men are at work developing a copper mine. Everything needed for the mine is carried down packed upon the backs of sure-footed burros. Even the water has to be brought in kegs from a little spring still deeper in the cañon.

The trail leaves the mine and winds down past another cliff, until, when more than three thousand feet from the top of the plateau, we find water for the first time. The little springs issue from the sandstone, and their limited supply of water is soon drunk up by the thirsty sands.

As far as the water flows it forms a little oasis upon the barren slope. Along the course of the streams are little patches of green grass, flowers, and bushes. Birds flit about, and there are tracks of small animals in the mud. Evidently the water is as great an attraction to them as it is to us. If a well were dug in the plateau above, we can understand now how deep it would have to be in order to reach water. A well three-fourths of a mile deep would be a difficult one to pump.

We are now in the bottom of the main cañon, but deeper still is the last and inner gorge, through which the Colorado is flowing. For thousands of centuries the river has been sawing its way down into the earth. The precipitous cliffs which we have passed are formed of hard sandstone or limestone. The more gentle slopes consist of softer shales. Now the river has cut through them all and has reached the very heart of the earth, the solid granite.

This inner gorge has almost vertical walls twelve hundred to fifteen hundred feet high. We can sit upon the brink under a ledge of rock which protects us from the hot sun, and watch the river as we eat our luncheon. Far below, almost directly under us, it rushes along. The roar of the current rises but faintly to our ears.

FIG. 6. — THE INNER GORGE OF THE GRAND CAÑON OF THE COLORADO

The water is very muddy and not at all like the clear mountain streams, far away upon the continental divide, which unite to form the river. It seems as if the water, ashamed of its soiled appearance, wanted to hide from the sight of men. If so, it has succeeded well, for it can be seen only at rare intervals from the top of the cañon walls, and even at the bottom of the main cañon the river itself is not visible unless one stands upon the very brink of the granite gorge.

The work of the river is not yet done. It will go on until the great cliffs have crumbled and have been replaced by gentle slopes. It will not stop until, at some far distant time, a broad valley has been worn out of the rocky strata.

The cañon appears much wider when viewed from the bottom than from the top, and the great cliffs far back along the trail seem less precipitous, but only because they are so far away. A weary climb of several miles awaits us. We must rest and take breath frequently or we shall not reach the top.

As night approaches and the shadows begin to fall, every turret and pinnacle stands out in bold relief. The bands of yellow and red shade into purple, and everything, save the long winding trail, begins to have a weird and mystical look.

HOW THE COLUMBIA PLATEAU WAS MADE

YEARS ago people disputed as to the way in which the earth was made. Those who lived where all the rocks had, like lava, the appearance of having once been melted, believed that fire had done all the work. Those who lived where the rocks appeared to be formed of hardened mud, sand, and lime, substances such as we find accumulating under water, said that water alone had been the means. But in later years the earth's surface has been more widely explored, and now it is known that both opinions were partly right. Water and fire have both been concerned in the making of the earth.

In the great valleys fire-formed rocks are rare, but they are more or less abundant in all mountainous regions, for where mountains are, there the crust of the earth is weakest. There are many reasons for believing that the interior of the earth is very hot. We know that the surface is settling in some places and rising in others, and that where the strain of the upheaval is too great the rocks are broken. These convulsions sometimes cause earthquakes and sometimes volcanic eruptions, when enormous quantities of molten rock are poured out over the surface. In all the long history of our earth probably no greater flood of lava than that which made the Columbia plateau was ever spread over the surface of any region. Travel where you will over the plains of southern Idaho, central Washington, or Oregon, and examine the rocks which here

and there rise above the soil or are exposed in the cañons, and you will find that they all appear to have been formed by fire.

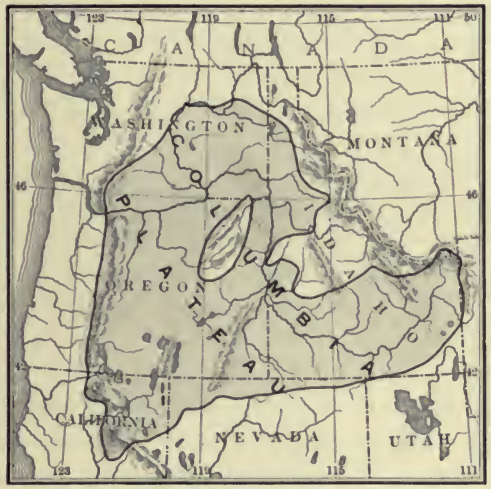
These rocks are dark in color and very hard. They are not arranged in regular layers like sandstone and shale; many of them show numerous little cavities which once con-

FIG. 7.—SNAKE RIVER AT IDAHO FALLS
Just beginning to cut a cañon in the volcanic plateau

tained steam. These cavities give to the rock a slag-like appearance. In this kind of rock, which we shall call lava, there are, of course, no remains of shells or bones of animals such as are often found in rocks formed from sand or clay.

Do not picture to yourself the Columbia plateau as one continuous stretch of level land, for it is broken by many

mountain ranges. Some of these are old mountains which were too tall to be buried by the lava, but most of them have been formed out of the plateau itself. The eruptions which made the plateau extended through a very long time, perhaps hundreds of thousands of years, and the older lava is deeply decayed and covered with



MAP OF THE COLUMBIA PLATEAU

soil. Some of the later flows show extremely rough and rugged surfaces and are probably only a few hundred years old.

Long ago, before the eruptions began, the geography of the Northwest was very different from what it is now. Instead of a vast plateau there were mountains and valleys. Lowlands occupied most of the region where the Cascade Range now rises with its lofty volcanic peaks. Portions

of the basin of the present Columbia River were occupied by lakes which extended southwest into California.

Movements of the earth began to affect the region of the present plateau, and at many points the solid rocks were fissured and broken. Then from that mysterious region far beneath the surface came steam and gases, escaping through the fissures with explosive force. In some places cinder cones were built about the openings by the fragments of lava which were hurled out. In other places, during periods of less explosive eruption, molten lava flowed out in vast quantities. The lava was very hot and almost as liquid as water, so that it spread in thin sheets over hundreds of square miles of lowland.

One important series of fissures through which eruptions took place marked the line where the Cascade Range was to be built. Other volcanoes appeared over the surface of southern Idaho, central Washington, Oregon, and northeastern California.

The eruptions were not continuous over the whole field; now in this place, now in that, there came long periods of quiet. During such periods the earthquakes ceased, the lava became cold, and the clouds of volcanic ashes cleared from the air. Frequently the lava intercepted streams and blocked the valleys so that large lakes were formed. Whenever the periods of quiet were very long, plants spread over the surface and animals of many kinds made their homes about the lakes.

In eastern Oregon the John Day River and its branches have eroded cañons through the later lava and have exposed the sands, clays, and gravels which collected at the bottom of one of those ancient lakes. In these beds the skeletons of many strange and interesting animals have been found.

Evidently they had once lived about the borders of the lake, and the streams had washed their bones into the water and mingled them with the sediment.

One of these animals appears to have been an ancestor of the present horse. It was about the size of a sheep, and had three toes instead of one. Another, probably a

FIG. 8.—BLUE LAKES, IDAHO

Formed by springs issuing from underneath the lava of the plateau

very dangerous animal, was related to our present hog, but stood nearly seven feet high. Others resembled the rhinoceros, camel, tapir, or peccary. All but the peccary are now extinct upon this continent. Of the carnivorous animals there were wolves and cats of large size.

The eruptions continued, filling the valleys little by little, until in places the lava reached a thickness of nearly

four thousand feet. The lower mountains were hidden from sight. We know of the existence of these buried mountains because the wearing away of the lava in some places has exposed their summits to view.

The lava flood reached farther and farther. In southern Idaho it formed the Snake River plains, which must have been, when first formed, hundreds of miles long, seventy-five miles wide, and almost as even as a floor. If we could have looked on while these things were taking place it would have appeared as if the whole land was about to sink under the fiery mass which flowed out of the earth. The streams and valleys were completely buried. The region of the John Day Lake, with all its animal remains, was covered. The lava, like a sea, crept up against the mountains surrounding the plateau region. Bays of lava extended into the valleys among the mountains, while mountain ridges rose like islands and capes from the surface of the flood.

We never tire of looking at the lofty snow-capped peaks of the Cascade Range. A dozen of them rise over ten thousand feet, and two, Mounts Shasta and Ranier, are more than fourteen thousand feet high. All these mountains were formed of material thrown out of the interior of the earth during the building of the Columbia plateau. The process was very similar for each. About some one exceptionally active crater immense quantities of scoriæ [1] and lapilli [2] accumulated. Then came streams of fiery lava, some of which, hardening upon the outer slopes of the crater, added still more to the growth of the mountain. The process was very slow, however. A time of eruption,

[1] *scoriæ*, cellular, slaggy lava.

[2] *lapilli*, volcanic ashes, consisting of small, angular, stony fragments.

marked by tremblings of the earth, explosive noises, and a sky filled with dust and clouds, might last for many years. Then came a long period of rest when the falling rains, gathering in dashing torrents, cut deep gullies down the sides of the mountain.

FIG. 9. — PITT RIVER CAÑON, NORTHERN CALIFORNIA
The plateau is built of layers of lava

The volcanoes at last ceased to grow any higher, for the lava, if the eruptions continued, formed new craters at their bases. It is probable that all these great peaks have been extinct for several thousand years, although some are much older and more worn away than others. One of these volcanoes has completely disappeared, and in its place lies that wonderful sheet of water known as Crater

Lake. It is thought that the interior of this mountain was melted away during a period of activity, and that the outer portion fell in, leaving a crater five miles across and nearly a mile deep.

The streams of lava, as they flowed here and there building up the plateau, frequently broke up the rivers and turned them into new channels. As time went on the eruptions were less violent, and the rivers became established in the channels which they occupy to-day. The Columbia River, winding about over the plateau, sought the easiest path to the sea. It soon began to dig a channel, and now has hidden itself between dark walls of lava.

But other forces besides the streams were now at work in this volcanic region. The lava plateau began slowly to bend upward along the line of the great volcanoes, lifting them upward with it. In this manner the Cascade Range was formed. The Columbia River, instead of seeking another way to the sea, continued cutting its channel deeper and deeper into the growing mountain range, and so has given us that picturesque cañon which forms a most convenient highway from the interior of Washington and Oregon to the coast.

Take a sheet of writing paper, lay it upon an even surface, then slowly push the opposite edges toward each other. This simple experiment will aid one in understanding one of the ways in which mountain ranges are made. Besides the upward fold of the plateau which made the Cascade Range, another was formed between the Blue Mountains in eastern Oregon and a spur of the Rocky Mountains in northern Idaho. This fold lay across the path of the Snake River, but its movement was so slow that the river kept its former channel and in this rising

land excavated a cañon which to-day is more than a mile deep. The upper twenty-five hundred feet of the cañon are cut into the lava of the plateau, and the lower three thousand into the underlying granite. The cañon is not so picturesque as the Colorado, for it has no rocks with variegated coloring or castellated walls. Its sides are, however, exceedingly precipitous and it is difficult to enter.

FIG. 10. — SHOSHONE FALLS, SNAKE RIVER, IDAHO

Along portions of the lower Columbia and Snake rivers, navigation is obstructed by rapids and waterfalls. The presence of these falls teaches us that these streams are still at work cutting their channels deeper. The Snake River in its upper course has as yet cut only a very shallow channel in the hard lava, and the beautiful Shoshone Falls

marks a point where its work is slow. These falls, which are the finest in the northwest, owe their existence to the fact that at this particular spot layers of strong resistant lava cover the softer rocks.

There are other cañons in the plateau region which are fully as remarkable as those which have been mentioned. That of the Des Chutes River in central Oregon is in places a thousand feet deep, with almost vertical walls of lava.

We have already seen how mountains have been formed upon the Columbia plateau, by a bending of the earth upward. Other mountains of the plateau are due to fractures in the solid rocks, often many miles long. Upon one side of these fractures the surface has been depressed, while upon the other it has been raised. The amount of the uplift varies from a few hundred to thousands of feet. The mountains thus formed have a long, gentle slope upon one side and a very steep incline upon the other. They are known as "block mountains," and those upon the Columbia plateau are the most interesting of their kind in the world.

With the exception of a few large rivers, the greater portion of the Columbia plateau is remarkable for its lack of surface streams. The water which reaches the borders of the plateau from the surrounding mountains often sinks into the gravel between the layers of lava and forms underground rivers. The deep cañons which have been mentioned intercept some of these underground rivers, so that their waters pour out and down over the sides of the cañons in foaming cascades. The greatest of these cascades is that known as the Thousand Springs in the Snake River cañon. The waters of the Blue Lakes in the cañon of the same river below Shoshone Falls also come

FIG. 11. — CAÑON OF CROOKED RIVER NEAR THE DES CHUTES RIVER
Eroded in the Columbia plateau

from underneath the lava. They are utilized in irrigating the most picturesque fruit ranch in southern Idaho.

The climate of the plateau is dry, and its eastern portion is practically a desert. Toward the west, however, the rainfall is greater, and in central Washington and northern Oregon the plateau becomes one vast grain-field. It is difficult to irrigate the plateau because the streams flow in such deep cañons, but above the point where the cañon of the Snake River begins there is an extensive system of canals and cultivated fields. With a sufficient water supply, the lava makes one of the richest and most productive of soils. Along the Snake and Columbia rivers, wherever there is a bit of bottom land, orchards have been planted. Little steamers ply along these rivers between the rapids, gathering the fruit and delivering it at the nearest railroad point.

Mining is carried on only in the mountains which rise above the lava flood, for the mineral veins are for the most part older than the lava of the plateau. We are certain that many very valuable deposits of the precious metals lie buried beneath the lava fields.

It is thought that the volcanic history of the Columbia plateau has been completed. Now the streams are at work carrying away the materials of which it is composed and may in time uncover the old buried land surface.

THE CAÑONS OF THE SIERRA NEVADA MOUNTAINS

The western half of our country contains the deepest and most picturesque cañons in the world. Those of the Colorado and Snake rivers form trenches in a comparatively level but lofty plateau region. The cañons of the Sierra Nevada Range, on the contrary, take their rise and extend for much of their length among rugged snow-capped peaks which include some of the highest mountains in the United States. All these cañons are the work of erosion. The rivers did not find depressions formed ready for them to occupy, but had to excavate their channels by the slow process of grinding away the solid rock.

The streams of the Sierra Nevada mountains begin their course in steep-walled alcoves under the shadows of the high peaks, where they are fed by perpetual snow-banks. Soon they bury themselves between granite walls, which at last tower three thousand feet above their roaring waters. After many miles the cañons widen, the walls decrease in height, and the streams come out upon the fertile stretches of the Great Valley of California.

Nature works in many ways. Her tools are of different kinds, but the most important one is running water. The forms which she produces are dependent upon the kind of rock upon which she works. Where the surface of the earth is soft the results of her labor are not very interest-

ing, but if the crust is hard the forms which she produces are often so remarkable that they arouse our wonder and admiration.

In shaping the Sierra Nevada mountains Nature had a grand opportunity. Here she produced the Yosemite Valley, which has a setting of cliffs and waterfalls that

FIG. 12.— SAN JOAQUIN RIVER EMERGING UPON THE PLAIN OF THE GREAT VALLEY

attract people from all over the world. Hetch-Hetchy Valley at the north of the Yosemite, and Tehipite and King's River cañons at the south, are interesting places, but not so majestic and inspiring as the Yosemite.

Nature never seems satisfied with her work. After she has created a piece of wonderful scenery she proceeds to destroy it. The great cliffs of the Yosemite will sometime lose their grandeur and be replaced by gentle slopes down which

the streams will flow quietly. The mountains of the Laurentian highlands in the northeastern portion of the continent undoubtedly were once lofty and picturesque, but there were no people upon the earth at that time to enjoy this scenery. Now these mountains have become old and are nearly worn down.

FIG. 13. — WHERE THE CAÑONS BEGIN UNDER PRECIPITOUS PEAKS
The head of the King's River

In one portion of the earth after another, Nature raises great mountain ranges and immediately proceeds to remove them. This continent was discovered and California was settled at the right time for the Sierra Nevadas to be seen in all their grandeur.

When the pioneers came in sight of the Sierra Nevada (snowy range), they little dreamed of the cañons hidden among these mountains. Gold, and not scenery, was the

object of their search. The great cañons were outside of the gold regions, and so inaccessibly situated that no one except the Indians looked upon them until 1851. In that year a party of soldiers following the trail of some thieving Indians discovered and entered the Yosemite Valley, but it was not explored until 1855. For many years the valley could be reached only by the roughest trails, but as its advantages became more widely known roads were built, and there are now three different wagon routes by which it may be entered.

The history of the Yosemite Valley is like that of all the other cañons of the Sierra Nevada mountains. Long ago there were no high mountains in eastern California. If there had been explorers crossing the plains in those days, they would have found no rugged wall shutting them off from the Pacific. There came a time, however, when the surface of the western portion of America was broken by violent earthquake movements, and hundreds of fissures were formed. Some of the earth blocks produced by these fissures were shoved upward, while others were dropped. One enormous block, which was to form the Sierra Nevada, was raised along its eastern edge until it stood several thousand feet above the adjoining country. The movement was like that of a trap-door opened slightly, so that upon one side — in this case the western one — the slope was long and gentle, while upon the east it was very abrupt.

Nature, the sculptor, took this mountain block in hand, and with the aid of running water began to carve its surface into a most intricate system of cañons and ridges. The streams first flowed over the easiest slopes to the Great Valley of California, but soon they began to cut

FIG. 14.—THE YOSEMITE VALLEY

their way down into the granite, while along the crests of the ridges the more resistant rocks began to stand out as jagged peaks.

Thus Nature worked until the mountains promised before long to be well worn down. The cañons had widened to valleys and the rugged slopes had given place to gentle ones. Toward the northern end of the range the work was even farther advanced, for the streams, now choked with gravel and sand, flowed over broad flood plains. In this gravel was buried a part of the wealth of California. The rocks over which the streams flowed contained veins of quartz with little particles of gold scattered through it, and as the surface rock crumbled and was worn away, the gold, being much heavier, slowly accumulated in the gravel at the bottom of the streams. This gold amounted in value to hundreds of millions of dollars.

The forces within the earth became active again. Apparently Nature did not intend that the gold should be forever buried, or that the country should always appear so uninteresting. Internal forces raised the mountain block for a second time, tilting it still more to the westward. Volcanoes broke forth along the summit of the range near the line of fracture, and floods of lava and volcanic mud ran down the slopes, completely filling the broad valleys of the northern Sierras and burying a great part of the gold-bearing gravel.

The eruptions turned the streams from their channels, but on the steeper slope of the mountains the rivers went energetically to work making new beds. They cut down through the lava and the buried gravel until they finally reached the solid rock underneath. Into this rock, which we call "bed-rock," they have now worn cañons two thou-

sand feet deep. The beds of gravel that lay under the old streams frequently form the tops of the hills between these deep cañons. Here they are easily accessible to the miners, who by tunnels or surface workings have taken out many millions of dollars' worth of gold.

The important cañons of the northern Sierras, where the gold is found, have been made by the American and Feather rivers. Farther south are the deeper and more rugged cañons of the Tuolumne, Merced, King's, and Kern rivers, which open to us inviting pathways into the mountains.

It might be supposed that the mantle of snow and ice which at that time covered most of the surface of the earth would have protected it from further erosion, but this was not the case. In the basin at the head of each stream the snow accumulated year after year until it was more than a thousand feet deep. Under the influence of the warm days and cold nights the snow slowly turned to ice, and moved by its own weight, crept down into the cañons. The solid rock walls were ground and polished, and even now, so long a time after the glaciers have melted, some of these polished surfaces still glisten in the sunlight. The glaciers deepened and enlarged the cañons, but running water was the most important agent in their making.

Upon the disappearance of the glaciers, the streams went to work again deepening their cañons. From their starting-points, under the lofty crags, they first ran through broad upland valleys, then tumbled into the cañons; but until they had reached the lower mountain slopes, to which the glaciers had not extended, they passed through a dreary and desolate region devoid of almost every sign

of life. The glaciers had swept away all the loose rock and soil, and it was many long years before the surface again crumbled so that forest trees could spread over it once more.

The grandeur and attractiveness of the Yosemite is partly due to the precipitous cliffs enclosing the valley, some of which are nearly four thousand feet in height, partly to the high waterfalls, and partly to the green meadows and forest groves through which the Merced River winds.

Although the glaciers had little to do with the making of the Yosemite Valley, yet they added to its attractiveness. The valley is situated where a number of smaller streams join the Merced River. Erosion was more rapid here because the granite was soft, while the vertical seams in the rock gave the growing valley precipitous walls. When the glacier came it pushed out the loose rocks and boulders, and dropping a portion of them at the lower end, made a dam across the Merced River. At first a shallow lake filled the valley, but after a time the silt and gravel which the streams were continually bringing in filled the lake, and formed marshy flats. Finally, grasses and trees spread over these flats and gave the valley the appearance which it has to-day.

Besides the meadows, the glaciers gave us two of the waterfalls. Yosemite Creek, which comes down over the walls twenty-seven hundred feet in three successive falls, was turned into its present channel by a dam which a glacier had left across its old course. A glacier also turned the Merced River at its entrance to the main valley so as to form the Nevada Fall.

After the valley had been made and clothed in vegetation, it was discovered by a small tribe of Indians who came here to make their home, secure from all their ene-

FIG. 15.—THE CAÑON OF BUBB'S CREEK, A BRANCH OF THE KING'S RIVER CAÑON

mies. There were fish in the streams and animals in the woods. The oaks supplied acorns, and in early summer the meadows were covered with strawberries. Legends were associated with many of the cliffs and waterfalls, for the Indians, like ourselves, are impressed by the wonders of Nature.

Hetch-Hetchy Valley, twenty-five miles north of the Yosemite, has been formed upon much the same plan, but a portion of its floor is marshy and there are few waterfalls. King's River Cañon has no green meadows and no high waterfalls, while its great granite walls are not so precipitous as those of the Yosemite. Next to the Yosemite, in the wildness of its scenery, is Tehipite Cañon. This cañon is situated upon the middle fork of King's River, about a hundred miles south. For many miles its walls and domes present ever changing views.

A continual struggle is going on between the forces within the earth and the sculptor working upon its surface. First one, then the other, gains the advantage. Where the mountains are steep and high, often the forces within have recently been active. Where they are low and the slopes are gentle, the sculptor has long held sway. She begins by making the surface as rough and picturesque as possible, but after a time she destroys her own handiwork.

AN OREGON GLACIER

THERE are records all about us of events which took place upon the earth long before there were any human inhabitants. These records have been preserved in the rocks, in the geographic features of the land and water, and in the distribution of the animals and plants. On every hand appear evidences of changes in the surface of the earth and in the climate.

Through all the central and northern United States, if we except some of the mountains of the West, the winter snows entirely disappear long before the coming of summer. But the climate of this region has not always been so pleasant and mild. Lands now densely peopled were once buried under a thick mantle of ice which lasted through many thousands of years.

Scattered over the surface of the northern United States are vast numbers of boulders and rock fragments which are not at all like the solid rocks beneath the soil. The history of these materials takes us back to the Glacial period, which can be best understood from a study of some one of the glaciers now existing upon the mountains of the northwestern part of our country.

Among the lofty mountain ranges of the Cordilleran region there are many peaks upon which perpetual snow-banks nestle, defying the long summer days. Where the winters are long and cold and the storms are severe, immense drifts of snow collect in the hollows and cañons of

the mountain slopes. Each summer all or a part of this snow melts. Upon the northern slopes the melting process is slower, and if there happens to be a large basin upon that side, an extensive field of snow remains until the winter storms come again. Each winter new snow is added to the surface, while the older snow, becoming hard and firm through repeated freezing and thawing, at last turns to ice.

This mass of snow and ice does not remain stationary, as might be expected from its apparent solidity. Under the influence of its own weight and of alternations of heat and cold, it flows down the incline like a very thick liquid. During the winter the ice melts but little, and the movement is slow, but in the summer, under the influence of the warm days and cool nights, both the melting and the rate of flow of the ice are increased. A moving body of snow and ice of this sort is called a "glacier." It creeps down the mountain slope and into some cañon, until, in the warmer air of the lower mountains, the rate of advance is exactly balanced by the rate of melting at the lower end of the mass. The glaciers in the United States are at present comparatively small, but once these icy masses stretched over the mountains and lowlands of a large portion of the continent.

In the southern Sierra Nevada mountains no permanent snow exists below an elevation of about eleven thousand feet, but as we go north snow-fields are found lower and lower, until in the fiords of Alaska enormous glaciers reach down to the sea.

A glacier worthy of our study may be found upon the Three Sisters, a group of lofty and picturesque volcanic mountains rising from the summit of the Cascade Range in central Oregon. There is a deep depression between two

of the peaks, which slopes down to the north and is thus particularly well adapted to catch and retain the drifting snows. Consequently the glacier to which it gives rise is of exceptional size, being nearly three miles long and half a mile wide.

The easiest path to the Three Sisters is by way of the McKenzie River from Eugene, Oregon. The

FIG. 16. — THE THREE SISTERS, FROM THE NORTH

Showing snow-fields and glacier. Fields of recent lava appear in the foreground

McKenzie is a noted stream and one of the most beautiful in the state. The river courses through dense forests, and its clear, cold water is filled with trout. So tempestuous is the weather about the Cascade range that July is almost the only month in which one can visit the Three Sisters without danger of being caught in severe storms.

The traveller leaves the river a few miles above

McKenzie Bridge, where a small tributary known as Lost Creek joins it. Lost Creek flows under the lava from a lake near the Three Sisters, while another stream, coming from the glacier of which we are in search, flows down the same valley upon the surface of the lava and almost directly over the hidden stream.

Upon the summit of the Cascade Range the dense forests of the river valley give place to more open woods interspersed with park-like meadows. A few miles away to the south rise the volcanic peaks of the Three Sisters, clear and cold in the mountain air, wrapt about with a mantle of white except where the slopes are too precipitous to hold the snow.

An indistinct trail leads through the tamarack forest and over a field of rugged lava to the base of the peaks. Here we come upon a swiftly flowing stream of a strange milky color. This appearance is due to the presence of fine mud, the product of the work of the glacier at the head of the stream as it slowly and with mighty power grinds away the surface of the rocks over which it moves. Wherever one meets a stream of this kind, he will probably be safe in asserting that it is fed by a glacier upon some distant mountain peak.

This little stream, the course of which we must follow to reach the glacier, is choked with sand and pebbles brought to it by the moving ice. These are not ordinary stream pebbles, for they have strangely flattened sides which often show scratches, and look as if they had been ground off against a grindstone. They are the tools with which the ice does its work. The ice block takes up the rock fragments which fall upon its surface or which it tears from beneath, and carries them along, grinding every

surface which it touches. The fragments are dropped at the end of the glacier, and the smaller pebbles are washed away down the stream that flows from the melting ice.

We follow up the little glacial creek, past icy snow-banks and through groves of fir trees where the warm sunshine brings out the resinous odors. Upon one side of

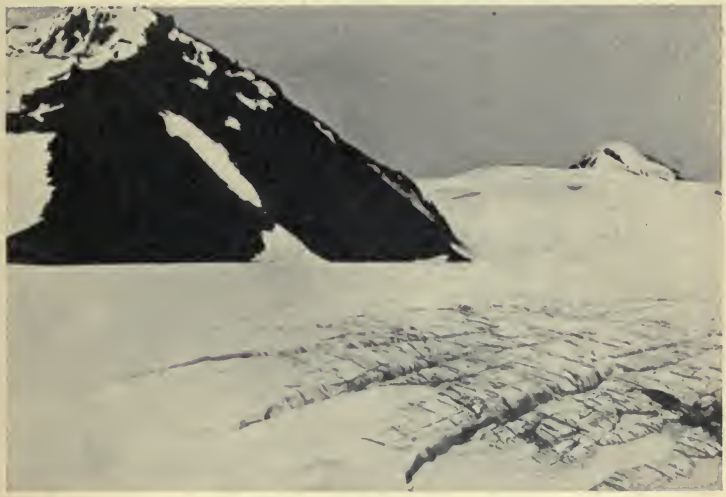


FIG. 17. — GLACIER ON THE THREE SISTERS

the cañon there lies a field of black lava which not many hundreds of years ago forced this glacial creek from an earlier channel into its present bed. Now we come upon what appears at first to be a snow-bank lying across the course of the stream, and from beneath which its waters issue. Deep cracks in the outer mass of snow show the clear, pale-green ice below. This is the lower end of the glacier which we have been so long a time in reaching.

A short climb up a steep slope brings us to the top of the glacier. It forms a perfectly even plain, extending back with a gentle slope to the head of a deep notch between the two northern Sisters, while above and beyond rise the steeper snow-fields, from which this ice is continually renewed.

The glacier does not terminate in the usual manner, with a stream flowing from its centre, for the outlet is at one side, while the middle abuts against a low mound of rock. This mound we find most interesting, for upon reaching its top we look down into a volcanic crater. From this crater flowed the great stream of lava to which we have already referred. The lava ran downward, bending this way and that among the hollows, until it spread nearly to the McKenzie River.

During the Glacial period, before the eruption took place, this glacier was much larger. The summit of the Cascade Range was then covered by glaciers. This fact we know from the presence of grooved and polished rocks wherever the surface has not been worn away or covered with newer lava. The Glacial period had passed away and the climate had become much the same as it now is when the volcanic forces broke out at the spot where the crater is situated. The eruption undoubtedly melted the ice in the vicinity, but after it had ceased and the rocks had become cold, the glacier never gained strength enough to push the loose materials of the volcanic cone out of its path. The ice banked up snugly against the obstruction, and as it melted the water found its way out at the side of the lava.

Although the surface of the glacier appears at first to offer an easy route to the higher mountain slopes, yet there are numerous hidden crevices into which one may fall,

The safest arrangement is to tie a company of people together with a stout rope, so that if one falls into a crevice the rope will save him. Toward the middle of the glacier the ice becomes so badly fissured that it is necessary to turn toward the right margin. There are two sets of these fissures, one parallel to the direction in which the glacier is

FIG. 18. — MORAINE AT THE END OF THE GLACIER

moving, the other at right angles. They are due to the strain to which the ice is subjected as it moves along at an uneven rate and over a surface composed of hollows and ridges.

Leaving the glacier, we climb upon a long low ridge of gravel and boulders mixed with fragments of ice. The fragments of rock which have fallen upon the surface of the ice or been torn from the rock over which it is moving, have been heaped up along its sides somewhat as a

ridge of snow is raised along each side of the course of a snow-plough. Such a ridge of débris along the side of a glacier is known as a marginal moraine. A similar ridge, formed by the accumulation of rock fragments at the lower end of the glacier, is a terminal moraine. These ridges and hollows formed by the ice are found all over the northern portion of the United States. The hollows once filled with ice are now occupied by the beautiful lakes of this portion of our country.

As we climb along the moraine at the margin of the glacier, many openings appear in the clear green ice. There is the sound of gurgling waters, and occasionally pieces of ice and rock fall into dimly outlined caverns which are narrow at the top, but far below widen out to the proportion of chambers.

After the head of the glacier is attained there is still a hard climb over the snow-fields, which extend upward so far that they seem to have no end. When at last the gap between the peaks is gained we are completely tired out. The summit of the middle Sister rising directly above us is still a thousand feet higher, but there is not time to-day to reach it.

A magnificent vista is spread out upon every hand. Extending north and south along the crest of the Cascade Range there is a line of sharp snowy peaks with summer clouds floating about them. How these peaks contrast with the dark blue of the surrounding forests! Opposite us, upon the south, is the third Sister, white with snow from top to bottom, while in the basin between this peak and the ridge on which we are standing lie the remnants of a once mighty glacier.

But it is time to return. The cold, foggy clouds are hid-

ing the summits and will soon envelop the spot where we stand. We go down by a different path, but over almost continuous snow-fields, for more than two miles. The return is much easier than the ascent, although if one lost his footing upon some steep slope, it would mean a long slide or tumble. The solid earth is reached without acci-

FIG. 19. — A BOULDER LEFT BY A GLACIER

dent. What a relief to have some firm hold for the feet again! Climbing over a field of rough lava is easier than toiling through soft snow.

The region about the Three Sisters is just as nature left it, for the home of the nearest settler is many miles away. Although now it has few visitors, this country will become attractive when its wonderful volcanic and glacial phenomena are better known.

SOMETHING ABOUT EARTHQUAKES AND MOUNTAIN BUILDING

Our everyday experiences lead us to feel that nothing is more permanent than the features of the earth upon which we live. Great cities containing costly buildings are built by the water's edge with the expectation that the ocean will remain where it is. The building of railroads and canals, and the establishment of industries to make the earth more fruitful and better adapted to our use, are based upon the idea that the mountains and valleys with their various climates will not change.

The study of history, however, makes plain the fact that at different times in the past certain portions of the earth have been visited by destructive changes. Cities have been shaken down by earthquakes, and the ocean has swept in over the land, drowning thousands of people. Even the mountains, which stand upon broad and firm foundations, sometimes bring disaster, by means of avalanches and land-slides, to the people who live at their bases.

The truth is that the earth's surface is everywhere slowly and quietly changing; but our lives are so short, and the history of even the oldest cities is so brief in comparison with the rate at which most of the changes take place, that we as a rule are aware of only the uncommon and sudden ones.

The occurrence of earthquakes establishes the unmistakable fact that there are forces at work from within disturb-

ing the surface, while land-slides, and even little gullies washed out by the rain, show that other forces are working from without.

The vibration or trembling of the earth which we call an "earthquake" always arouses alarm, and frequently occasions great destruction and loss of life. Only a few of the various causes that may bring about earthquakes are as yet fully understood. Earthquakes are very interesting, however, because they are often associated with the birth and growth of lofty mountain ranges.

Volcanic eruptions, hot springs, and the high temperature which exists toward the bottom of deep mines show us that the interior of the earth is very hot. It is thought that at one time the whole earth glowed with heat, but as ages passed it became cold upon the outside and a solid crust was formed.

Every one has observed that fruit becomes wrinkled as the pulp within dries and contracts. The materials of the earth occupy more space when they are hot than when cold, and as the interior portion is still cooling, the outer layer or crust continues to shrink down upon it, forming folds or wrinkles, as in the case of the skin of an apple.

There is probably no portion of the surface that is fixed in its present position. The land is either rising or sinking continually. If the area that is pushed upward is large, it becomes a plateau; but if long and narrow like a wrinkle, it forms a mountain range. We should not be aware of these movements in many cases if it were not for the horizontal shelf cut upon the borders of the land by the ocean waves. Along some coasts old wave-cut cliffs stand hundreds of feet above the present ocean

level. Other coasts have sunk, so that the water has flooded the adjoining land and made a new shore line.

When the movements of the land are sudden, they manifest themselves to us through earthquakes. The crust of the earth is not so flexible as the skin of an apple, and when the strain upon it becomes too great it suddenly breaks. The rock walls usually slide past one another along such a fracture. If the rising wall becomes high enough it will form a mountain range.

The great mountain systems border the oceans, for the lines of weakness occur where the land dips steeply down beneath the water. It sometimes happens that the fractures in the rocks where mountains are being made are situated underneath the water, or in some position where water passes down through them in large quantities.

What do you think would happen if such an underground stream of water came in contact with hot or molten rocks far below the surface? Note the effect produced by drops of water falling upon a hot stove. Each one, as it strikes, is partly changed to steam with a slight explosive sound. The result is similar when water is turned into the hot and nearly empty boiler of a steam-engine — an explosion is sure to follow.

When the pressure of steam suddenly formed within the earth is too great, a volcanic explosion takes place at some point where the overlying rocks are weakest, probably on or near one of the lines of fracture about which we have been speaking. The explosion is accompanied by thundering noises, tremblings of the earth, and the hurling of rock and molten lava into the air. That the rocks of the earth's crust are elastic is shown by the rebounding of a pebble thrown against a large boulder. If a file be drawn across

the edge of a sheet of tin upon which sand has been sprinkled, the tin vibrates over its whole extent, as is shown by the jumping of the sand grains. Because of like elasticity in the materials which make up the surface of the earth, the vibrations produced by an explosion are carried through the solid earth for hundreds of miles.

FIG. 20. — EARTHQUAKE FISSURES NEAR MONO LAKE, CALIFORNIA

The records of earthquakes show that they are much more violent and occur oftener where the crust of the earth is being disturbed by folding. We have seen that there are two main causes of earthquakes: the slipping of portions of the earth past each other along a fissure, and the contact of water with very hot rocks far below the surface. It is probable that the earthquakes which occur so often in the western portion of the United States

are due to the first of these causes. The numerous extinct volcanoes show that at one period this region was frequently shaken by explosive eruptions.

Mono Lake (see Fig. 42, page 99), at the eastern base of the Sierra Nevada Range, has been a centre for explo-

FIG. 21. — THE WASATCH RANGE
From Salt Lake City

sive eruptions, which were extremely violent at one time. The islands which rise in the lake are shattered, while Black Point, upon the northern shore, has been uplifted by an explosion from beneath, which split the rocks apart and formed deep fissures.

It is an interesting fact that in the Cordilleran region the mountains have been increasing in height in very re-

cent years. We might almost say that they are growing to-day. In this region, then, we can actually see how mountains are made; we do not have to depend upon descriptions of the manner in which they are supposed to have been made thousands of years ago.

Any good map will show that the mountains of the Cordilleran region have in general a north and south

FIG. 22. — BLUFF FORMED BY AN EARTHQUAKE
At the foot of the Wasatch Range, Utah

direction. Their direction was determined by fissures formed long ago in the crust of the earth. Movements have continued to take place along many of these fissures up to the present time, and probably will continue for some time to come.

In order to become better acquainted with these remarkable mountains, let us examine some of them, taking first the Wasatch Range in eastern Utah. The range has an elevation of nearly eleven thousand feet, rising gradually

upon the eastern side, but presenting a bold and picturesque front upon the west, toward the plain of Great Salt Lake. A short drive from Salt Lake City brings us to the foot of the range, at the mouth of Little Cottonwood Cañon.

A peculiar bluff which extends for a number of miles along the base of the mountains at once attracts our attention. The steep face of the bluff, which is from fifty to seventy-five feet high, appears to have been formed by a rising of the land upon the side next the mountains, or a dropping upon the valley side. There are reasons for believing that the formation of the bluff was due to the occurrence of an earthquake some time within the last century. The bluff is closely related to the mighty mountains behind it. It was formed by the last of a series of movements in the earth which raised the great block known as the Wasatch Range to an elevation of six thousand feet above the plains at its base. Is it to be wondered at that disturbances of the earth which result in the erection of mountains of such height are frequently so severe as to destroy the strongest buildings?

Now let us go westward across the various parallel ranges of the Great Basin to Owens Valley at the eastern base of the Sierra Nevada mountains. This is the highest and longest continuous mountain range in the United States. For a distance of more than one hundred miles its elevation is from twelve thousand to over fourteen thousand feet.

Owens Valley was in 1872 the centre of one of the most severe and extensive earthquakes ever recorded in the United States. The little village of Lone Pine, situated in the valley below Mount Whitney, was utterly

FIG. 23. — EASTERN FACE OF THE SIERRA NEVADA MOUNTAINS
Formed by a great fracture in the earth's crust

demolished, twenty people were killed and many injured. A portion of the valley near the village sank so low that the water flowed in and formed a lake above it. The land was so shaken up that the fields of one man were thrust into those of his neighbor. For a distance of several hundred miles to the north along the base of the mountains the earth was fractured, and bluffs from ten to forty feet high were formed as a result either of the dropping of the surface of the valley upon the eastern side, or of the raising of the mountains upon the west.

This slipping of the earth which gave rise to the earthquake bluffs was the most recent of a long series of similar events which have raised the precipitous eastern wall of the Sierra Nevada mountains to a height of two miles above Owens Valley. If you will go out into the centre of the valley and look west toward the mountains, you will see three bluffs or scarps. The first, which is twenty feet high, was made at the time of the last earthquake; the second, known as the Alabama Hills and rising about four hundred feet, was formed at an earlier time; the third, rising back of the others, is that of the main Sierra.

Similar cliffs appear at the bases of other ranges of mountains in the Great Basin. Springs abound along these fractures in the earth, for the surface waters have an opportunity to collect wherever the rocks are broken. Numerous fertile valleys mark the line of earthquake movements, for the broken rocks and abundant springs favor rapid erosion.

Among the Coast Ranges of California there appears a series of fractures in the earth which form a line nearly four hundred miles long. They extend from a point near San Bernardino in a northwesterly direction to the neigh-

borhood of San Francisco. Severe earthquakes have taken place along this line since the country was settled. The pressure and grinding of the earth upon opposite sides of the fissures has formed long low ridges of earth. Small valleys have been blocked, and the old stage road from Los Angeles to Bakersfield, which followed the course of the fissures for a number of miles, has been almost obliterated.

FIG. 24. — ELIZABETH LAKE, CALIFORNIA
Occupying a valley primarily due to earthquake movements

Hundreds of cliffs and mountain scarps throughout the West have come into existence as the results of movements such as we have been describing. Where the disturbances have been recent the mountains are bold and picturesque. Those produced in earlier times are in many instances so worn away that it is difficult to tell with certainty how they were made.

THE LAST VOLCANIC ERUPTIONS IN THE UNITED STATES

THERE are more volcanoes in our country than is generally supposed. Some are very small and some rank among the greatest of mountain peaks, but all together there are many hundreds, perhaps thousands, of them. At present they are all silent and apparently dead. We are accustomed to speak of them as extinct volcanoes, but of this we must not be too sure.

They stand dark and cold, giving no clue to the nature of the forces which made them, except perhaps by the presence of an occasional hot spring and the appearance of the rocks of which they are composed. The slag-like character of these rocks we have learned to associate with intense heat. Some of these volcanoes are very old and have been nearly worn away; others are new and almost as perfect as when they were first made.

Where shall we go to find these volcanoes? Are there any upon the Atlantic coast or neighboring highlands? Though you may travel over all that portion of our country, you will find none, although you will discover in places, as for instance in the palisades of the Hudson, lavas which came from very ancient volcanoes, worn down so long ago that their very sites are lost to view.

If we search the Mississippi basin we find there even fewer traces of volcanic action than upon the eastern highlands. The greater portion of the vast area embraced by the

Mississippi River and its tributaries has had a very uneventful history, although at times earthquakes may have occurred and the sky may have been darkened by ashes from eruptions in distant parts of the earth.

It is in the country west of the Rockies, the region last to be explored and settled, that the objects of our search come to light. Here are volcanoes and lava fields so ex-

FIG. 25.— FISSURE IN THE LAVA, SHADOW MOUNTAIN
The groovings in the lava show that it was squeezed out in a half-solid condition

tensive as almost to bury from sight the older surface of the earth. Some of them appear as if but yesterday they had been glowing with heat.

In the Cordilleran region Nature has carried on her work with a master hand. She has lifted the earth's crust to form a great plateau. Portions of the plateau she has broken, projecting the fragments upward to form lofty

mountains, while along the fissures thus created she has squeezed out fiery molten matter from the interior of the earth. This molten material has spread out in fields of lava or has piled itself about small openings, forming volcanic cones, which in some cases have overtopped the loftiest mountain ranges of the continent. It is believed that a number of these volcanic eruptions have occurred in the Cordilleran region of the United States since the discovery of America, and that one took place within the lifetime of many persons now living.

San Francisco Mountain, in northern Arizona, is the loftiest volcanic peak of a region dotted with volcanoes and lava flows. This great volcano, like most of its neighbors, has long been extinct, although a few miles to the eastward there appears a group of small but very new cones.

A ride of fifteen miles from the town of Flagstaff, across the forest-covered plateau, brings us to Shadow Mountain and the fields of lava and volcanic sand lying at its base. The mountain, throughout its height of over one thousand feet, is a conical aggregate of loose lapilli which give way under the feet and make climbing the peak very tiresome.

The lapilli and scoriæ are slag-like fragments of lava which have been blown out of the throat of the volcano while in a hot or semi-molten condition. These fragments, as they fall back to the earth, collect about the opening and in time build up the volcano, or cinder cone, as such a mountain is frequently called. The finer particles, which have the appearance of dark sand, fall farther away and form a layer over the surface for some miles upon every side. These products of an explosive volcano are sometimes called cinders and ashes, because of their resemblance to the slag and refuse of furnaces.

In the case of the volcano which we are studying, the lapilli are so black that they give the cone the appearance of being darkened by the shadow of a cloud, and on this account the peak is named Shadow Mountain. As the days are usually bright here, the shadow effect is very striking.

FIG. 26. — EDGE OF LAVA FIELD, WITH PUMICE IN THE FOREGROUND Near Shadow Mountain

There are several smaller craters, east of the main one, which also threw out volcanic sand and lapilli. The surrounding hills are of volcanic origin, although very much older than Shadow Mountain. These hills are covered with pine forests; but trees or plants have gained only

slight hold upon the newer surfaces of the cinder cones, which present a picture of almost complete desolation.

There have been two other eruptions since the making of the cinder cones, and these were marked by flows of molten lava. Although the rough and rugged surface of the older flow has not yet begun to crumble and form soil, as it must do in time, yet a few trees are found here and there, reaching their roots down for the scanty nourishment to be drawn from the crevices of the rocks.

The last flow of lava, which was very small, ran into a depression in the other flow just described. This lava appears so fresh that we almost expect to find the rocks still warm. What a contrast between the wooded hillside adjoining, with its carpet of soft volcanic sand, and the jagged surface of the lava! Care must be taken in climbing over the lava, for the sharp points and angles are ever ready to tear one's shoes and hands. It cannot be many years since these hard, cold rocks formed a glowing mass of molten matter creeping quietly out of some hidden fissure which reached far down into the earth. The lava hardened as it became cold, just as does molten iron when led from the furnace to make a casting.

At one spot in the lava field stand the remains of rude stone houses built into caverns in the lava. About them are scattered pieces of broken pottery. These rude dwellings were probably occupied by some of the prehistoric people whose homes are also found along many of the streams, and in the caves of the plateau region. We can see no reason for their coming to this desolate place, so far from a water supply, unless it was that the rugged lava offered some protection from their enemies.

Now let us imagine ourselves transported to northern California. Near Lassen Peak, the southernmost of the great volcanoes of the Cascade Range, there lies another field of recent volcanic activity of even greater interest than the first. The centre of attraction is Cinder Cone, similar to Shadow Mountain in its manner of formation as well as in materials, but more symmetrical in form. Upon one

FIG. 27. — THE CRATER OF CINDER CONE

side is a field of black lava several miles in extent, while volcanic sand has been spread over all the adjacent country.

As nearly as can be determined, only a little more than two hundred years ago the valley now occupied by Cinder Cone and the lava fields gave no indication of ever becoming a new centre of volcanic action. It has been thousands of years since the ancient volcanic peaks and

cinder cones of this mountainous region became extinct. The glaciers had come, and torn and ground away the surface of the lava, and afterward dense forests had hidden all the rocky slopes, while lakes had occupied many of the valleys. Far below, however, the fires had not gone out. In many places there were boiling springs from which the steam, upon cold mornings, rose in dense white clouds.

Then, for some reason which we do not understand, the forces beneath the surface increased their activity. The force of the steam and other gases was too great to be restrained, and at a weak spot in the overlying rocks they broke through. Molten lava accompanied them, and a new volcano came into life in the valley where Cinder Cone now raises its dark, symmetrical slopes.

The eruptions were violent. With explosive force the molten lava was torn into fragments, and sand, lapilli, and bombs were hurled out into the air. The finer particles were carried by the air currents far over the surrounding country. The lapilli, scoriæ, and bombs fell around the throat of the volcano, finally building up the cone to its present proportions. The great bombs, some of them five feet in diameter, are among the most remarkable products of this eruption. They lie scattered about upon the surface of the ground at the foot of the cone, and, although they are often irregular in shape, they might almost be mistaken for huge cannon-balls. The eruption killed and burned the trees in the near-by forests, burying them under six or seven feet of fine sand or ashes. After the cone had been built and the explosive eruptions had nearly stopped, a stream of molten lava burst from the base of the cone and filled a portion of the valley.

Now followed a long period of quiet. Trees began to

grow upon the sand and gradually to encroach upon the barren wastes about Cinder Cone. It appeared as if there were to be no more eruptions. But the volcano was only resting. At about the time, perhaps, when the gold seekers began to pour across the continent to California, there was another eruption; but this time it took

FIG. 28. — CINDER CONE
The trees were killed by the last eruption of volcanic ashes

the form of a lava flow and was so quiet as to create no disturbance in the surrounding country.

A stream of thick, viscous lava flowed slowly out of an opening at the southern base of Cinder Cone. As the lava crept down the gentle slopes of the valley, it crusted over, forming a black, slag-like surface. The surface was from time to time broken up and mixed with the softer

portions beneath, so that the movement of the flow was still further retarded. At the lower end of the valley the lava occupied a portion of a body of water now known as Lake Bidwell; its rugged front made a dam across the valley above, forming Snag Lake. The stumps of the

FIG. 29. — THE LAST LAVA FLOW IN THE UNITED STATES

At Cinder Cone, California. It formed a dam across a valley, thus creating Snag Lake

trees which were killed by the water when the lake was first formed are still standing.

One's feet sink deep into volcanic sands, and walking is tiresome. The lava field resulting from the last eruption is free from sand, but its rough surface, formed of broken blocks, is difficult to cross.

A few charred stumps rise out of the sand, pathetic remnants of the forest trees that were growing at the

time of the first eruption. Most of the trees have completely disappeared, leaving shallow pits where they once stood.

It is exceedingly difficult to climb the cone, which rises over six hundred feet, for the slopes, composed of loose lapilli, are so steep that one slips back at every step nearly as far as he advances. From the summit a remarkable sight meets the eye. Within the rim of the main crater is a second crater with a rim nearly as high as the first, while the cavity within has a depth of about two hundred and fifty feet.

Because of the loose character of the material of which it is built, no streamlets have yet worn channels down the slopes of Cinder Cone, and except for the presence of two small bushes which cling to its side, it is just as bare and perfect in form as when first completed.

Little by little the forests are encroaching upon the sand-covered slopes about the cone, and in time these slopes, the black fields of lava, and the cone itself, will be covered with forests like the older lava fields and cinder cones which appear upon every hand.

THE MUD VOLCANOES OF THE COLORADO DESERT

The Colorado Desert is a strange, weird region. Here is a vast basin at the head of the Gulf of California which was once a part of the gulf, but is now separated from it by the delta of the Colorado River. With the drying up of the water, the centre of the basin was left a salt marsh more than two hundred and fifty feet below the level of the ocean. In summer the air quivers under the blazing sun, and it seems as if no form of life could withstand the scorching heat, but in winter the atmosphere is cool and full of life-giving energy.

Around this desert rise the mountains, some old and nearly worn down, their tops barely rising out of the long slopes of sand and gravel; others rugged and steep, lifting their crests far above the burning desert into the cold, clear sky.

Curious forms of plants and animals find their homes upon the slopes about the basin, where they adapt themselves to the heat and dryness. But toward the centre the soil is bare clay, for when the water dried up so much alkali and salt were left that nothing could grow.

However we do not now intend to study the plants or the animals, interesting though they are, but rather a group of mud volcanoes, which forms almost the only relief in the monotony of the bare plain. These volcanoes are in no way related to real volcanoes except in shape, for water

and mud, instead of fire and lava, have been concerned in their building.

Once it required a long journey in wagons or upon horseback to reach the mud volcanoes, but now the railroad takes us within three miles of the spot. We alight from the train before a section house which stands in the

FIG. 30. — MUD VOLCANOES, COLORADO DESERT

midst of the great desert. Far, far away stretches the barren clay floor of the ancient lake. Here and there are scattered stunted shrubs, the only specimens of plant life which have been able to withstand the alkali in the clay.

Seen from the station, the volcanoes appear like dark specks almost upon the horizon, but in reality they are not far away, and an hour's brisk walk will bring us to them. The mud springs, which are scattered over an area

of several hundred acres, present many strange and interesting features. There are holes in the earth with bubbling mud at the bottom, cones from the tops of which streams of muddy water issue, and ponds of mud, in some cases as thick as molasses, in others thin and watery. There are little jets of steam, strange odors, and a vista of many mingled colors. Taken altogether, it is a place quite different from any other that we have ever seen.

The ground is soft and marshy, and in some places undermined by the water, so that we have to take great care in walking about. Some of the smaller springs occupy round depressions, sometimes three or four feet across, which look as if they had been made by pressing a large pan down into the clay. The bubbling mud in the bottom of the pan, as well as the hot water in many of the springs, makes it easy to imagine that we are standing upon the top of a great cooking stove in which a hot fire is burning. As the gas with which the water is impregnated comes up through the mud, it forms huge bubbles which finally break and settle down, only to rise again. In this way concentric mud rings, perfect in form, are made to cover the entire surface of the pool.

Where there is little water, the surface of the mud hardens and leaves a small opening, through which the bubbling gas throws small columns of mud at regular intervals. From the large pools, some of which are forty to fifty feet in diameter, there comes a low murmuring sound like the boiling of many kettles. The water is sputtering and bubbling, and in some places it is hot enough to give off thin clouds of steam. Occasionally we get whiffs of sulphur, while about the borders of some of the ponds pretty crystals of this mineral can be found.

More commonly the pools are crusted about with a white deposit of salt, for they all contain more or less of this substance in solution. Around a few of the pools the mud is stained with the red tinge of iron, and red lines mark the paths of the streams as they run off from the pools toward the still lower portions of the desert.

FIG. 31. — POT-HOLES

The built-up cones or volcanoes appear in every stage, from the little ones a few inches high to the patriarchs, which in some cases have reached a height of twelve feet. These cones are formed by the hardening and piling up of mud about the openings; but when they have reached the height mentioned, the passages up through their centres, corresponding in each case to the throat of a real volcano,

become clogged and new holes are formed in the mud at the base.

Many of these mud volcanoes closely resemble true volcanoes in form and structure. The mud which pours out at the top forms streams down the slopes very like those of molten lava. New cones are built upon the sides or at the bases of the old ones in much the same way as are those in the volcanic regions.

FIG. 32. — AN EXTINCT MUD VOLCANO
With small active one at its side

There are no signs of volcanic action in the vicinity of these mud springs, and it is likely that the water is forced to the surface by large quantities of gas produced by chemical changes taking place deep within the clay beds of the old lake. Similar springs occur farther south, nearer the mouth of the Colorado River, in the Yellowstone Park, and near Lassen Peak, but nowhere in America except in the Colorado desert have they formed such large and interesting mounds.

THE HISTORY OF A COAST LINE

The story of our Pacific coast reads more like a tale from the "Arabian Nights" than like a plain statement of events which have actually happened.

The meeting place of the land and ocean is not really so permanent a line as it appears. The shore has been continually moving back and forth throughout the long history of the earth. That which was dry land at one time was at another time deeply buried beneath the ocean. The Pacific border seems never to have been at rest. It has risen and sunk again repeatedly. It has been squeezed, folded, and broken, shaken by earthquakes, and disturbed by volcanic eruptions.

One might be led to think from this statement that it would not be safe to live on the Pacific coast, and that both animals and men would shun the region. The fact is, however, that these changes usually come to pass so very slowly that we are not aware of them. Severe earthquakes and volcanic disturbances take place so rarely in comparison with the length of a man's life, that we may pass our whole lives without experiencing any of these violent disturbances. The Pacific coast region, with its forest-covered mountains, fertile valleys, and beautiful homes, presents so quiet and peaceful an appearance that it is difficult to believe that parts of its history have been so tumultuous.

Perhaps you will ask how we can know so much about

the past. It is true that no one was here to witness the events which are supposed to have taken place. But Nature has left a record of her doings which we have only to see and understand in order to learn with certainty many things which happened in the far distant past.

Too many of us go through life seeing and understanding almost as little of the world about us as if we were blind. Our early ancestors were obliged to understand many things about Nature and to cultivate clear and close observation for the sake of self-preservation. The very life of the savage depends upon the training of his eyes. He must be able to tell the meaning of a distant object or an indistinct trail, for his enemies may have passed that way recently. If we could bring the sharp eyes of the savage to our aid, the world would mean much more to us.

In order to learn something of the history of the Pacific shore line, we must see what the waves are doing at the present time. The projecting points of land are being worn away (Fig. 33). The waves form the cliffs against which they beat, and sometimes, as they eat their way slowly into the land, they cut off portions and leave them standing alone as islands.

The pebbles and boulders (Fig. 34) were once angular fragments torn from the cliff. They have been washed about and hurled against the solid rock until they have been worn smooth; and the cliff in turn has had a cave ground out at its base. Above the lower cave there is a remnant of a second one, with pebbles upon its floor. This was made when the land stood ten feet lower than at present.

As the waves wear away the loose earth and the solid rock below it, moving the cliffs inland, they leave a com-

paratively smooth surface which is partly exposed at low tide. The fact that this surface is not marked by stream channels, as is the land, helps us to realize the great difference between the irregular surface of the latter and the plain-like character of the ocean floor.

Along the whole coast of California there are many old sea beaches and cliffs which the waves abandoned long

FIG. 33. — POINT BUCHON, CALIFORNIA
The waves are eating their way into the land

ago. The highest of these beaches lies so far up the slopes of the mountains bordering the ocean that it makes us wonder what the geography of California could have been like when the region was so deeply submerged.

The lowest and newest terrace is the one shown in Fig. 35, ten feet above the ocean. Each succeeding terrace is less distinct, and the highest, fourteen hundred feet in elevation, can now be distinguished in only a few places.

Where the old sea cliffs are best preserved they form a series of broad, flat steps, rising one above the other. Each bench, or terrace as it is commonly called, is a part of an old plain cut out of the land by the waves when the ocean stood at that level. The steeper slope rising at the back is the remnant of the cliff against which the waves used to

FIG. 34.—OCEAN CAVE AT LOW TIDE
Pebbles of a former beach are seen above

beat. If we are fortunate, we shall find at its base some water-worn pebbles and possibly a few fragments of sea-shells. The crumbling of the rocks and the erosive action of the rills are fast destroying the old cliffs, so that in many places they have entirely disappeared.

Upon the seaward face of San Pedro Hill, in southern California, there are eleven terraces, rising to a height of twelve hundred feet. What an interesting record this

shows! Long ago the land stood twelve hundred feet lower than at present, and the waves beat about San Pedro Hill, nearly submerging it. Then the land began to rise, but stopped after a time, and the waves cut a terrace. The upward movement was continued, with repeated intervals of rest, until the land stood higher than it does now.

FIG. 35.— WAVE-CUT TERRACES
Point San Pedro, California

North of San Francisco there stands a terrace fourteen hundred feet above the ocean. Numerous terraces appear along the Oregon coast, but those in Washington are not as high as those in California. It is probable that the land in this region was not so deeply submerged.

The ancient shore lines of British Columbia and Alaska are now deeply buried beneath the ocean, as those of Cali-

fornia once were. The fiords, so common in these countries, are old river valleys which have been drowned by the sinking of the land. The islands were once portions of the coast mountains, but have been cut off by the same process.

Let us picture in our minds the changes in the geography of the Pacific coast of the United States which must have been made by a sinking of the land to a depth of only six hundred feet. We will begin upon the north, at the Strait of Fuca.

Puget Sound once opened to the south as well as to the north, so that the Olympic Mountains formed an island. The broad and fertile Willamette Valley was but an arm of the sea, somewhat like Puget Sound to-day. The body of water which once filled this valley has been called Willamette Sound. The ocean overspread the low Oregon coast, and reached far up the valleys of the Umpqua and Rogue rivers. But the boundaries of the Klamath Mountains were not greatly changed, for in many places they rise quite abruptly from the present shore line.

All the large valleys of California were flooded, including the San Joaquin-Sacramento valley, which was then a great sound, open to the ocean in the region of the present Strait of Carquinez. The Coast range was broken up into islands and peninsulas. The islands off the coast of southern California are high and therefore were not entirely submerged. The Gulf of California spread over the Colorado Desert, while from the west the water penetrated inland over the plain of Los Angeles to a point beyond San Bernardino, so that at the San Gorgonio pass only a narrow neck of land connected the San Jacinto Mountains and the Peninsula Range with the mainland.

If California had been inhabited at this time, the state would not have been noted for orchards and grain-fields, but rather for its mineral wealth. There would have been comparatively little low land fit for cultivation, but the mountains, where almost all the precious metals are found, would have appeared nearly as they do to-day.

The surface of the earth may be divided into the ocean basins and the continental masses which rise above them, but we must not make the mistake of thinking that the shore line always corresponds with the border of the continental masses. We have learned that the land is almost always moving slowly up or down, so that the shore is continually changing back and forth. At one time the shore line may be far within the borders of the continent, as we have seen was once the case upon our Pacific coast; at another time, if the land should rise, the shore line might coincide with the real border of the continent. By the real border of the continent we mean the line along which the earth slopes down steeply to the abysmal depths of the ocean.

It is an interesting fact that outside the present shore line of California there is a submerged strip of the continent varying from ten to one hundred and fifty miles in width. This strip of land is like a bench upon the side of the continent, and is known as the continental plateau. The water over the plateau is comparatively shallow. Upon one side the land rises, while upon the other there is a rapid descent into the deep Pacific. The surface of the plateau is in general fairly smooth, but in places mountains lift their summits above the water and form islands.

There was a time, thousands of years earlier than the

period when California was so nearly covered by the waters of the Pacific, when this land stood far higher than it does now. The coast line was then much farther west, near the border of the submarine plateau. The Santa Barbara Islands at that time formed a mountain range upon the edge of the continental land. This fact was established by the discovery upon one of the islands of a large number of bones of an extinct American elephant. These animals could have reached the submerged mountains only at a time when there was dry land between them and the present shore line. We should like to know how it came about that these bones were left where they are. Perhaps the land sank so suddenly that the water cut the elephants off from the mainland and compelled them to spend the remainder of their lives upon these islands.

While the land stood so high, some of the larger streams wore deep channels across what is now the submarine plateau. These channels have been discovered by soundings made from the ships of the United States Coast Survey. The largest of the submerged valleys extends through the Bay of Monterey, and runs so close to the shore that it has offered a favorable location for a wharf.

Before the buried valleys upon the northern coast of California were all known, the presence of one of them led to the wreck of a ship. The shore was obscured by fog, but the soundings made by the sailors showed deep water and led them to believe they were a long distance from land, when suddenly the ship drifted in upon the rocks.

The last significant movement of the land of the Pacific border was a downward one. It flooded the mouths of the streams and formed all the large harbors which are of so great commercial importance.

San Francisco Bay occupies a great stretch of lowland at the meeting of several valleys of the Coast Ranges and forms the outlet for the most important drainage system of California. If this region had been settled before the subsidence of the land which let in the ocean through the Golden Gate, how the farmers would have lamented the flooding of their fertile lands! But we can understand how small the loss would have been, compared

FIG. 36. — ISLAND ROUNDED BY A GLACIER
Near Anacortes, Puget Sound

with the advantages to be gained from the magnificent harbor which now exists here. If the land had not sunk the history of the Pacific coast would have been far different.

Puget Sound, another very important arm of the ocean, is also a submerged valley, but it has had an entirely different history from that of San Francisco Bay. The valley was at one time occupied by a great glacier which

came down from the Cascade Range and moved northwest through the sound and into the Strait of Juan de Fuca, scouring and polishing the rocks over which it passed. A little island near Anacortes (Fig. 36) has been rounded by the action of the ice into a form like a whale's back.

The sinking of the land flooded the lower Columbia River and the mouth of the Willamette, so that ocean ships

FIG. 37. — AN ABANDONED OCEAN CLIFF
Southern California

may now go up as far as Portland. The currents and waves soon threw up bars across the mouths of the smaller streams, and formed lagoons behind them. Ships frequently have difficulty in entering many of the harbors because of the sand bars which have been built up part way to the surface of the water.

It is thought that along some portions of the coast there has recently been a slight upward movement of the land. Figure 37 shows a bit of California coast, near San Juan, where the Santa Fé railroad has laid its tracks for several miles along a strip of abandoned beach, at the base of a cliff against which the waves once beat.

FIG. 38. — LIMESTONE CLIFF, QUATSINO SOUND, VANCOUVER ISLAND

At the northern end of Vancouver island there is a deep arm of the ocean called Quatsino Sound. A limestone cliff upon the shore of this sound (Fig. 38) has been undermined by the dissolving of the limestone, but now the water lacks three feet of rising to the notch which it recently formed.

THE DISCOVERY OF THE COLUMBIA RIVER

The influence exerted by the various features of the land and water upon the settlement of a new region are not always fully appreciated. If the entrance to San Francisco Bay had been broader and more easily discerned by the early navigators who sailed past it, and if the mouth of the Columbia River had not been obscured by lowlands and a line of breakers upon the bar, the history of western America would probably have been very different.

In the seventeenth century the prospect seemed to be that Spain would control the Pacific Ocean. She claimed, by right of discovery, all the lands bordering upon this ocean and the exclusive right to navigate its waters. Every vessel found there without license from the court of Spain was, by royal decree, to be confiscated.

It is interesting, after all these years and with our present knowledge, to look back and see how unreasonable were the claims of Spain. In the fifteenth century the extent of the Pacific ocean was not known. In fact, men's ideas as to the distribution of land and water over the earth were so indefinite that it was at first supposed that the islands which Columbus discovered belonged to the East Indies.

The claims of Spain to the Pacific Ocean were based upon its discovery by Balboa, but she never made any serious efforts to enforce them, for the attempt would have involved her in war with all the maritime nations of Europe.

Spain lacked the ability to take advantage of the great discoveries which her navigators and explorers had made, and for that reason she merely looked on, though with jealous eyes, when in the eighteenth century the ships of England, France, Holland, and Russia entered the Pacific Ocean with a view to exploration and conquest.

Determined at last to support their claim to the Pacific coast of North America, the Spaniards began to realize the necessity of exploring it more fully and of founding settlements. It was their plan to take possession of the whole region between Mexico upon the south and the Russian trading posts along the shores of Alaska. As exploration by land was impossible because of mountain ranges and deserts, the Spanish adventurers were forced to rely upon the ocean, with all its uncertainties of storm and contrary winds.

Between 1774 and 1779 voyages were made as far north as Queen Charlotte's Island, in latitude 54°. A station was established and held for many years at Nootka Sound, upon the west coast of Vancouver Island. The first expedition passed the Strait of Juan de Fuca apparently without seeing it, although there was a rumor to the effect that a broad opening into the land had been discovered by a certain Juan de Fuca in 1592, while he was exploring in the employ of Spain. The latitude of this opening, as he gave it, nearly corresponds to that of the strait which now bears his name.

For many years the attempt to discover a passage around the northern part of America engaged the early navigators upon both the Atlantic and Pacific oceans. Their desire to find an easy route to India spurred them to constant effort. For a time it was believed that such an

opening actually existed, and mariners went so far as to give it a name, calling it the Straits of Anian. The reputed discoveries of Juan de Fuca materially strengthened the general belief in a passage to the northward of America.

Vizcaino, in his voyage of 1603, reached latitude 43° north and thought that he had discovered a great river flowing into the Pacific Ocean. This opening, although south of the point supposed to have been reached by Juan de Fuca, was believed for a time to be the entrance to the long-sought Straits of Anian. During the latter part of the seventeenth century California was represented upon the Spanish maps as an island having Cape Blanco, which Vizcaino discovered and named, as its northern point, and separated from the mainland by an extension of the Gulf of California northward.

To return now to the Spanish explorations, in the latter part of the seventeenth century we find that Heceta, following the first expedition, succeeded in getting as far as Vancouver Island, where, having been parted from an accompanying ship by a storm, he turned southward, passing the Strait of Juan de Fuca and keeping close by the shore. In latitude 46° 17′ he found an opening in the coast from which a strong current issued. He felt sure that he had discovered the mouth of some large river. Upon the later Spanish maps this was called Heceta's Inlet, or River of San Roque. A glance at the map will show how closely the latitude given corresponds to the mouth of the river which was discovered later by Captain Gray and named, after his ship, the Columbia.

A short time before Heceta's discovery, Captain Jonathan Carver of Connecticut set out on an exploring tour, partly for the purpose of determining the width of the

continent and the nature of the Indian inhabitants. He mentions four great rivers rising within a few leagues of one another, "The river Bourbon (Red River of the North) which empties itself into Hudson's Bay, the waters of the St. Lawrence, the Mississippi, and the river Oregon, or River of the West, that falls into the Pacific Ocean at the Straits of Anian." Carver's descriptions are fanciful, and it is not likely that he ever saw the river which is now known as the Columbia, although there is a possibility that he heard stories from the Indians of a great river upon the western slope of the Rocky Mountains, and invented for it the name Oregon.

In 1787 Meares, an English trader, visited the coast, and sailing southward from the Strait of Juan de Fuca, attempted to find the river San Roque as it was laid down upon the Spanish charts. Reaching the proper latitude, Meares rounded a promontory and found behind it a bay which he was unable to enter because of a continuous line of breakers extending across it. He became satisfied that there was no such river as the San Roque, and named the promontory Cape Disappointment and the bay Deception Bay. If Meares had entered the bay through the breakers, the English would undoubtedly have made good their claim to the discovery of the Columbia River.

After the Revolution, American trading ships began to extend their operations into the North Pacific. In 1787 two such vessels left Boston, one of them under command of a Captain Gray. After reaching the Pacific, the ships were parted during a storm, and Captain Gray finally touched the American coast near the forty-sixth degree of north latitude. For nine days he tried to enter an opening which was in all probability the one attempted by

Meares. After nearly losing his ship and suffering an Indian attack, he sailed north to Nootka Sound.

Captain Gray returned to Boston, but in 1790 started upon another trading expedition in command of the ship *Columbia*. Arriving safely in the North Pacific, he spent the winter of 1791–1792 upon Vancouver Island.

Vancouver, whose name has been given to the largest island upon the western coast of North America, and who did so much to make known the intricate coast line of the Puget Sound region, arrived upon the scene in 1792. He was authorized to carry on explorations, and to treat with Spain concerning the abandonment of the Spanish claim to Nootka Sound.

Vancouver sailed up the coast, keeping a close lookout for the river San Roque. No opening in the land appeared, although at one spot he sailed through a muddy-colored sea which he judged was affected by the water of some river. Upon reaching the Strait of Fuca, Vancouver expressed the opinion that there was no river between the fortieth and forty-eighth degrees of north latitude, "only brooks insufficient for our vessels to navigate."

Shortly after this time, Vancouver met Captain Gray with his ship *Columbia*. The disheartened explorer placed no confidence in Captain Gray's report that, upon his former voyage, he had discovered a large river to the south. Vancouver in his narrative says, "I was thoroughly convinced that we could not possibly have passed any safe navigable opening, harbor, or place of security for shipping on this coast from Cape Mendocino to the promontory of Closset" (Cape Flattery).

Captain Gray, however, determined to make further

investigations. He sailed southward and entered a port now known as Gray's Harbor, where he spent several days trading with the Indians. From this harbor he ran on south for a few miles past Cape Disappointment, and then sailed through an opening in the breakers into a bay which he supposed formed the mouth of the river of which

FIG. 39. — A SCENE ON GRAY'S HARBOR, WASHINGTON
Showing sawmills and log booms

he was in search. He finally anchored, as he says, "in a large river of fresh water."

Later Captain Gray took the vessel twelve or fifteen miles up the river, and would have gone farther if he had not wandered into the wrong channel. When he left the river he named it the Columbia in honor of his vessel. Thus by the right of actual discovery the United States was at last able to make good its claim to the river.

The English claimed that Gray did not enter the river itself, as the tide sets up many miles farther than the point which his ship reached. They insisted that what he saw was simply a bay. But the truth is that Gray was actually in the mouth of the river. The mere fact that the tide enters the lower portion of the river makes no difference. The actual mouth of the Columbia is marked by the north and south coast line. The entrance of the tide water, and the backing of the current for many miles up stream, is the result of a recent sinking of the land. The same features are presented by the Hudson River.

If the English had discovered and entered the river first it is probable that this stream would have become the boundary line between the United States and British Columbia, in which case the whole northern portion of the Oregon territory would have been lost to us. As it was, the English laid insistent claim to the northern bank of the river and established trading posts at various points. The lowest of these posts stood upon the site of Fort Vancouver, a little above the mouth of the Willamette River.

The famous exploring expedition under Captains Lewis and Clark wintered at the mouth of the Columbia in 1804–1805, in a group of rude log cabins known as Fort Clatsop. The first settlement in the vicinity was made in 1811, when a fur company organized by John Jacob Astor attempted to establish a trading post upon the Columbia. Two parties were sent out from New York. One travelled by water around Cape Horn, while the other, with great difficulty, crossed the continent by the way of the Missouri, Snake, and Columbia rivers. The undertaking proved unsuccessful, for after the War of 1812 began supplies could no longer be sent safely to the post.

The Astor company finally surrendered its establishment to an English company, and in this way the control of the river was transferred to England. With the return of peace the post was restored to the United States, and its location is marked now by the city of Astoria.

FIG. 40. — TILLAMOOK ROCK
Near the mouth of the Columbia River

What small things sometimes determine the trend of great events! A little more care and energy on the part of Vancouver or Meares would have placed the Columbia River in the hands of the English. The existence of an open river mouth without any breaking bar would have brought about the same result.

The Spaniards came first to the Pacific slope, claiming the whole coast as far north as the Russian possessions.

Later the United States, by treaty with Spain and Russia, acquired a right to all that portion of the Pacific coast of North America which lies between California and the Russian possessions. But because of the greater energy of the English, and the failure upon the part of the United States to realize the value of this vast region, a considerable section was again lost by the terms of the treaty which

FIG. 41. — ASTORIA, OREGON
At the mouth of the Columbia River

made the forty-ninth parallel the boundary line. The intelligence and energy of Captain Gray alone preserved to us the rich lands of Washington.

THE GREAT BASIN AND ITS PECULIAR LAKES

As our country was slowly being explored and settled, one region was brought to light which Nature seemed to have left unfinished and in a desolate condition. This barren stretch of country was once marked upon the maps as the Great American Desert, and included a large part of the extensive region lying between the Rocky Mountains upon the east and the Sierra Nevada Mountains upon the west. To the south lay the Grand Cañon of the Colorado, while upon the north the boundary was formed by the cañons of the Snake and Columbia rivers.

After a time it was found that this region, covering about two hundred and twenty-five thousand square miles, not only was extremely dry, but had no outlet to the ocean. A rim of higher land all about made of it so perfect a basin that it became known as the Great Basin. None of the water that falls upon the surface of this basin ever reaches the ocean through surface streams. Some of it soaks into the rocks, but the greater part is evaporated into the dry air.

We have already learned something about the way in which the ridges and hollows of the earth's surface are made. We have learned of the wrinkling of the crust, of the formation of fissures, and of the erosive work of running water. The interesting features of the Great Basin are mainly the result of two causes: the sinking of a portion of the earth's surface, and the lack of rainfall.

Long ago the Wasatch Range of eastern Utah and the Sierra Nevadas of California formed parts of a vast elevated plateau. Then there came a time when the forces holding up the plateau were relaxed, and as the weight of the plateau pressed it down, the solid rocks broke into huge fragments. Some of the blocks thus made sank and formed valleys; others were tilted or pushed up and formed mountains. Thus the north and south mountain ranges and valleys of the Great Basin were born.

We must understand, then, that the Great Basin is not a simple depression with higher land all about. The breaking up of the surface produced many basins, large and small. Some of these basins are six thousand feet above the level of the sea, others are much lower, and one has been dropped below the level of the sea, so that if it were not for barriers the water would flow in. Some of the basins are rimmed all about by steep mountains, others are so broad and flat that it is difficult to tell that they really are basins. Many of the valleys are so connected with one another that if a heavy rainfall should ever occur drainage systems would be quickly established.

The Great Basin now appears like the skeleton of a dried-up world; but if the climate should change and become like that of the Mississippi Valley, the surface of the desert would undergo a wondrous transformation. The hundreds of basins, if fed by streams from the surrounding mountains, would then become lakes. The highest, overflowing, would empty into a lower, and this in turn into a still lower basin, until the water had accumulated in vast inland seas. These seas, overflowing the rim of the Great Basin at its lowest points, would send rivers hastening away to the ocean.

What a region of lakes this would be for a time! Then they would begin to disappear, for lakes are short-lived as compared with mountains. Some would be filled with clay

and gravel brought by the streams. Others would be drained by a cutting down of their outlets.

Great Salt Lake, which is the only body of water in the Basin that has ever sent a stream to the ocean, was lowered four hundred feet by the washing away of the rock and earth at its outlet.

We know that the rainfall never has been heavy in this region since the Great Basin was formed, although at one time it was sufficiently great to form two inland seas, one in northwestern Nevada, the other in Utah.

The chief reason for the dryness of the Great Basin is the presence of that lofty barrier, the Sierra Nevada mountain range, between the Basin and the Pacific Ocean. The storms, which usually come from the ocean, are intercepted by this range, and the greater portion of their moisture is taken away. The little moisture that remains falls upon the highlands of the Great Basin, and so relieves its surface from utter barrenness. The adjacent slopes of the Sierra Nevada and Wasatch ranges furnish numerous perennial streams which feed the lakes about the borders of the Basin, such as Great Salt Lake, Pyramid, Walker, Mono, Honey, and Owens lakes. The wet weather streams, flowing down the desert mountains for a short time each year, frequently form broad, shallow lakes which disappear with the coming of the summer sun.

The climate of the Great Basin has changed from time to time. During one period it was much drier than it is now, and the lakes were nearly or quite dried up. It must have been a desolate region then, shunned by animals and forbidden to man.

During the Glacial period, a few thousand years ago, the climate was moister and cooler than it is now. The

mountains were covered with deep snows, and glaciers crept down the slopes of the higher peaks. Great Salt Lake covered all northwestern Utah ; to this former body of water the name Bonneville has been given, in honor of a noted trapper. Pyramid, Winnemucca, Carson, Walker,

FIG. 42. — MONO LAKE, CALIFORNIA

and Honey lakes, now separated from one another by sage-brush deserts, were then united in one great lake, to which the name Lahontan has been given, in honor of an early French explorer.

Lake Lahontan covered a large portion of northwestern Nevada and penetrated into California. It was broken into long winding arms and bays by various mountain

ranges. The deepest portion of this ancient lake is now occupied by Pyramid Lake, which is, perhaps, the most picturesque of all the Basin lakes. Fish can live in the waters of this lake, although nearly all the others are so salty or so alkaline that they support none of the ordinary forms of life.

FIG. 43. — ROUND HOLE, A SPRING IN THE SMOKE CREEK DESERT
Bed of old Lake Lahontan

Upon the Black Rock Desert, in northern Nevada, there are large springs once covered by Lake Lahontan, in which fish are found. It is thought that the ancestors of these fish must have been left there at the time of the drying up of the water.

After the Glacial period the present arid climate began to prevail in the land. Hundreds of the shallow lakes which had been scattered over this extensive region dis-

appeared. Others contained water for only a portion of each year. A body of water which is not permanent, but comes and goes with the seasons, we call a playa lake. Many of these playa lakes present in summer a hard, yellow-clay floor of many miles in extent and entirely free from vegetation. The beds of others are covered with a

FIG. 44. — ROGERS LAKE, MOHAVE DESERT
A playa lake

whitish crust, formed of the various salts which were in solution in the lake water.

An important feature of the lakes of the Great Basin is the presence of large quantities of such substances as common salt, soda, borax, and nitre. The ocean is salt because it has no outlet, while the rivers of the globe are continually bringing into it various minerals, dissolved from the rocks over which they flow. Lakes with outlets are not

salty, because with a continuous change of the water there is no opportunity for the minerals to accumulate, although they are always present in small quantities. Any lake which does not receive enough running water to cause it to overflow the borders of its basin, will in course of time become rich in various kinds of salt.

No two of the lakes of the Great Basin are alike in the composition of their waters. This fact may be due to a difference in the rocks about the lake basin, to the presence of varying mineral springs, or to the drying up of one or more of the lakes at some time so that their former salts were buried under sands and clays when the water again filled the basin.

Great Salt Lake contains little besides common salt. In Mono Lake, soda and salt are equally important constituents, while Owens Lake contains an excess of soda. In other basins borax was present in such quantities that when the waters dried up it formed important deposits. The value of these deposits is now fully understood, and many enterprising companies are at work separating and purifying the borax.

Owens Lake was once fresh, although now it is so strong with soda that it would destroy the skin if a bather should remain in it very long. The former outlet of this lake was toward the south, through a pass separating the Sierra Nevada from the Coso Mountains. For a distance of thirty miles the old river-bed has been transformed into a wagon road, and it is interesting to ride all day along the bed of this dead river, past bold cliffs against which the waters once surged and foamed. The river emptied far to the south, into a broad, shallow lake whose former bed is now white with soda and borax. The old beach lines

stand out distinctly upon the slopes of the enclosing mountains.

The lake bed is now the seat of an important industry — the gathering of the borax and its refining. There are extensive buildings at one spot upon its border, and men come and go across the blinding white surface. A twenty-mule team dragging three huge wagons creeps slowly along

FIG. 45. — FREIGHTING BORAX ACROSS THE DESERT

the base of the distant mountains, but all that can be distinguished is a cloud of dust.

The slow crumbling of the rocks, and the setting free of those constituents which are soluble, the work of the streams in gathering the rock waste into the lakes, the dry air and the heat of the long summer days, have all conspired together to give us these valuable deposits in the dried-up lakes of the Great Basin.

No portion of the earth seems to be without value to man. The great bodies of water are convenient highways. The rich valleys and timbered mountains offer useful products. Even the deserts, where living things of every description find the struggle for existence very hard, become indispensable. If the climate in the Great Basin had been

FIG. 46. — MUSHROOM ROCK, PYRAMID LAKE
Formed of calcareous tufa

moist, the salts would not have been preserved, but would have been carried away to the ocean, from which only common salt could have been recovered in commercial quantities.

The crossing of the Great Basin was dreaded by the early emigrants on their way to the Pacific coast. In many cases the locations of the few springs and water-courses were

unknown, and the journey over the vast barren stretches was fraught with danger.

Stand upon a mountain in the desert some clear day in summer and you will see range after range, with intervening sandy wastes, stretching away to the horizon. The air below is tremulous with heat, and every living thing that can move has sought the shade of some rock or cliff. The plants seem almost dead, for the little springs, hidden at rare intervals in the deep cañons, are of no use to them.

What transformations would be wrought upon these desert slopes if it were possible for the soil to receive and retain large quantities of water! Forest-covered mountains, green hillsides, rippling streams, lakes, farms, orchards, and towns would appear as if by magic.

FRÉMONT'S ADVENTURES IN THE GREAT BASIN

FRÉMONT, "the Pathfinder," did greater service than any other man in making known the geographic features of the Cordilleran region. In the fifth decade of the last century, while California still belonged to Mexico and the pioneers were turning their attention to the Oregon country, Frémont organized and conducted three exploring expeditions under the direction of the government. When in California upon the third expedition he took part in the skirmishes which resulted in the transference of this section to the United States.

A fourth expedition, undertaken by Frémont on his own account, resulted disastrously. The explorers foolishly tried to cross the Rocky Mountains in the middle of winter, but had to give up the attempt after many of the party had died from cold and starvation.

It is hard for us to realize, now, that only sixty years ago the territory lying between the Rocky Mountains and the Pacific coast was practically unknown. Try to imagine the feelings of emigrants, bound for the gold-fields of California, who have pushed into the Great Basin without knowing where to look for grass or water. They are camped by a spring of alkaline water scarcely fit to drink; their weary animals nibble at the scanty grass about the spring; far ahead stretches the pathless desert which they must cross; upon their choice of a route their very lives will depend.

Now it is all changed. The whole region is crossed and recrossed by wagon roads and railways. Many mining towns are scattered through the mountains which dot the seemingly boundless expanse of desert, while in every place where water can be found there are gardens, green fields of alfalfa, and herds of cattle.

Before the year 1840 some knowledge had been acquired of the borders of the Great Basin. Trappers and explorers had crossed the Rocky Mountains and had gone down the Columbia River. There were Spanish settlements in New Mexico, Arizona, and along the coast of California.

Frémont's first expedition had taken him to the summit of the Rocky Mountains in northwestern Wyoming. In 1843 he started upon the second expedition. He was at that time commissioned to cross the Rockies, descend the Columbia to Fort Vancouver, and return by a route farther to the south, across the unknown region between the Columbia and the Colorado rivers.

Let us follow the little band of explorers led by Captain Frémont as day after day they made their way across what was then a trackless waste, and see what troubles they encountered because of the inaccuracy of the maps of that period.

Leaving Fort Vancouver, upon the lower Columbia, for the return trip, the party ascended the river to The Dalles and then turned southward along the eastern side of the Cascade Range. They soon entered upon a region never before traversed by white men. At the time when autumn was giving place to winter, without reliable guides or maps, they were to cross the deserts lying between them and the Rocky Mountains.

They met with no great difficulties until they had gone as far south as Klamath Lake. "From this point," Frémont says, "our course was intended to be about southeast to a reported lake called Mary's, at some days' journey in the Great Basin, and thence, still on southeast to the

FIG. 47. — MAP OF A PORTION OF WESTERN NORTH AMERICA, MADE IN 1826
Showing the Buenaventura River

reputed Buenaventura (good chance) River, which has had a place on so many maps, and countenanced the belief in the existence of a great river flowing from the Rocky Mountains to the Bay of San Francisco."

Figure 47 shows one of the maps to which Frémont refers. How interesting it is! Compare it with a good map in your geography and you will readily see that it is

very misleading. The Sierra Nevada, one of the greatest mountain ranges in the United States, hardly appears, while traced directly across the map is the great Buenaventura River which Frémont expected to find and follow eastward toward its source near the Rocky Mountains.

If this river had really been where it was mapped, it is likely that Frémont would have had no trouble, for if hard pressed he could have followed the stream down to the ocean. But a wall of snow-covered mountains lying in the way made matters very different.

Winter was coming on when the party entered what is now northwestern Nevada, looking for the Buenaventura River. For several weeks they toiled on, often through the snow. Concerning this part of the journey Frémont says: "We had reached and run over the position where, according to the best maps in my possession, we should have found Mary's lake or river. We were evidently on the verge of the desert, and the country was so forbidding that we were afraid to enter it."

The party then turned south, still hoping that the river might be discovered. After a time they came upon a large lake and travelled for many miles along its eastern shore. One camp was made opposite a tall, pyramid-shaped island, the white surface of which made it conspicuous for a long distance. Frémont was much impressed by the resemblance of the island to the pyramids of Egypt and so named the body of water Pyramid Lake. At the southern end of the lake the travellers found a large stream flowing into it (now known as the Truckee River), and followed along its banks for some distance; but as the river turned toward the west, they left it and struck out across the country.

Frémont says again, "With every stream I now expected to see the great Buenaventura, and Carson (Kit Carson, the famous scout) hurried eagerly to search on every one we reached for beaver cuttings, which he always maintained we should find only on waters which ran to the Pacific."

But all the streams flowed in the wrong direction, until at last the explorers grew weary of hunting for the river

FIG. 48. — PYRAMID ISLAND, PYRAMID LAKE, NEVADA

which had no existence. Although it was the middle of the winter, Frémont determined to cross the lofty Sierras which rose like a white wall to the west. Once over the mountains, he hoped to gain the American settlements in the Sacramento Valley, where already Sutter's Fort had been established.

The party ascended Walker River, dragging, with great difficulty, a howitzer which they had brought with them.

The snows grew deeper as storm succeeded storm. Feeling that they were really lost, the disheartened men at length abandoned the gun, at a spot which has since been named Lost Cañon.

When their own provisions were nearly gone, the party obtained some pine nuts and also several rabbits from the Indians. A dog which had been brought along made

FIG. 49. — LOST CAÑON, EASTERN SLOPE OF THE SIERRA NEVADA MOUNTAINS

one good meal for the wayfarers. An Indian who had been persuaded to act as guide pointed out the spot where two white men, one of whom was Walker, a noted frontiersman, had once crossed the mountains; but the guide made them understand that it was impossible to cross at that time of the year, saying, in his own language, "Rock upon rock, snow upon snow."

Although they could advance only by breaking paths

through the snow, and were reduced to eating mule and horse flesh, yet the Frémont party pushed on. Finally they reached the summit of the mountains and turned down by the head of a stream flowing westward, which proved to be the American River. After three weeks more of terrible suffering they came out of the mountains at Sutter's Fort, where they obtained supplies and had an opportunity to rest and recruit.

FIG. 50. — FRÉMONT PEAK, MOHAVE DESERT

Frémont now recognized the incorrectness of the maps which had so nearly caused the destruction of the party. As he says in his notes: "No river from the interior does, or can, cross the Sierra Nevada, itself more lofty than the Rocky Mountains. . . . There is no opening from the Bay of San Francisco into the interior of the continent."

When the return journey was begun the party did not recross the high Sierras, but turned southward through

the San Joaquin Valley and gained the Mohave Desert by the way of Tehachapai pass. The route now led eastward across the deserts and low mountain ranges of California and southern Nevada, until at last Great Salt Lake was reached.

Among the many geographical discoveries of the expedition was the demonstration of the existence of the Great

FIG. 51. — SAGE-BRUSH IN THE GREAT BASIN

Basin. In his report, Frémont, while speaking of its vast sterile valleys and of the Indians which inhabit them, says: "That it is peopled we know, but miserably and sparsely . . . dispersed in single families . . . eating seeds and insects, digging roots (hence their name) [Digger Indians], such is the condition of the greater part. Others are a degree higher and live in communities upon some lake or river from which they repulse the miserable Diggers.

"The rabbit is the largest animal known in this desert, its flesh affords a little meat. . . . The wild sage is their only wood, and here it is of extraordinary size — sometimes a foot in diameter and six or eight feet high. It serves for fuel, for building material, for shelter for the rabbits, and for some sort of covering for the feet and legs in cold weather. But I flatter myself that what is discovered, though not enough to satisfy curiosity, is sufficient to excite it, and that subsequent explorations will complete what has been commenced."

THE STORY OF GREAT SALT LAKE

THE most interesting geographical feature of Utah is the Great Salt Lake. Few tourists now cross the continent without visiting the lake and taking a bath in its briny waters. This strange body of water has, however, been slowly growing smaller for some years, and probably will in time disappear. A study of the history of the lake may throw some light upon the important question of its possible disappearance, and it will certainly bring out many interesting facts.

We do not know with certainty who was the first white man to look upon this inland sea, although it is supposed to have been James Bridger, a noted trapper, who in 1825 followed Bear River down to its mouth. He tasted the water and found it salt, a fact which encouraged him in the belief that he had found an arm of the Pacific Ocean.

More than two hundred years ago there were vague ideas about a salt lake situated somewhere beyond the Rocky Mountains. In 1689 Baron Lahontan published an account of his travels from Mackinac to the Mississippi River and the region beyond. He states that he ascended a westerly branch of the river for six weeks, until the season became too late for farther progress. He reports meeting savages who said that one hundred and fifty leagues beyond there was a salt lake, "three hundred leagues in circumference —its mouth stretching a great way to the southward."

This imaginative story aroused interest in the West. In

a book published in 1772, devoted to a description of the province La Louisiane, the possibility of water communication with the South Sea is discussed as follows: "It will be of great convenience to this country, if ever it becomes settled, that there is an easy communication therewith, and the South Sea, which lies between America and China, and that two ways: by the north branch of the great Yellow River, by the natives called the river of the 'Massorites' (Missouri), which hath a course of five hundred miles, navigable to its head, or springs, and which proceeds from a ridge of hills somewhat north of New Mexico, passable by horse, foot, or wagon, in less than half a day. On the other side are rivers which run into a great lake that empties itself by another navigable river into the South Sea. The same may be said of the Meschaouay, up which our people have been, but not so far as the Baron Lahontan, who passed on it above three hundred miles almost due west, and declares it comes from the same ridge of hills above mentioned, and that divers rivers from the other side soon make a large river, which enters into a vast lake, on which inhabit two or three great nations, much more populous and civilized than other Indians; and out of that lake a great river disembogues into the South Sea."

In 1776 Father Escalante travelled from Santa Fé far to the north and west. He met Indians who told him of a lake the waters of which produced a burning sensation when placed upon the skin. This was probably Great Salt Lake, but it is not thought that he himself ever saw it. The Escalante Desert, in southern Utah, once covered by the waters of the lake, is named after this explorer.

Nothing more seems to have been learned of the lake after its discovery by Bridger until in 1833 Bonneville,

a daring leader among the trappers, organized a party for its exploration. Washington Irving, in his history of Captain Bonneville, says of the party, "A desert surrounded them and stretched to the southwest as far as the eye could reach, rivalling the deserts of Asia and Africa in sterility. There was neither tree, nor herbage, nor spring, nor

FIG. 52. — SCENE ON GREAT SALT LAKE

pool, nor running stream, nothing but parched wastes of sand, where horse and rider were in danger of perishing."

Although decreasing in area so rapidly, Great Salt Lake is still the largest body of water in the western part of the United States, and the largest salt lake within its boundaries. It has a length of seventy miles and a maximum width of nearly fifty miles.

Desolate, indeed, must have appeared the surroundings

of the lake, with its salt-incrusted borders, as the Mormon emigrants gained the summit of the Wasatch Range and looked out over the vast expanse to the west. But as the slopes at the foot of the mountains seemed capable of producing food for their support, they stopped and made their homes there. Now in this same region, after half a century, one can ride for many miles through as beautiful and highly cultivated a country as the sun ever looked down upon. In the early days the barren plains were broken only by mountains almost as barren, which rose from them like the islands from the surface of the Great Salt Lake. The only pleasing prospect was toward the east, where stood the steep and rugged Wasatch Range, with its snow-capped peaks. From its deep cañons issued large streams of pure, cold water, which flowed undisturbed across the brush-covered slopes, then unbroken by irrigating ditches, and at last were lost in the salt lake.

One might think that streams of water apparently so pure would at last freshen the lake, but in reality they are carrying along invisible particles of mineral matter which add to its saltness day by day. The dry air steals away the water from the lake as fast as it runs in, but cannot take the minerals which it holds in solution.

Great Salt Lake is still considered very large, but at one time it was ten times its present size, while still longer ago there was no lake at all. Without a basin there can be no lake, and at that far-away time, as we have already learned, the Great Basin did not exist, and the streams, if there were any, ran away to the ocean without hindrance.

When the Great Basin was formed by a breaking and bending of the crust of the earth, many a stream lost its connection with the ocean and went to work filling up the

smaller basins, thus giving rise to the lakes which have already been described. The largest of these bodies of water, and in some respects the most interesting, is Great Salt Lake.

This lake, lying close to the lofty Wasatch Range, received so much water from numerous streams during the Glacial period that it slowly spread over thousands of

FIG. 53.—OLD SHORE LINE OF LAKE BONNEVILLE
Foot of the Wasatch Range

square miles, overrunning the desert valleys and making islands of the scattered mountain ranges. It extended from north to south across Utah, into southern Idaho and almost to the Arizona line, until this body of water, which arose from so small beginnings, had become a veritable inland sea, three hundred miles long, one hundred miles wide, and one thousand feet deep.

By the time the lake had covered an area of twenty thousand square miles the lowest point in the rim of the basin was reached and the overflow began. No map will tell you where the outlet was, for no river exists there now. If you could explore the shore lines of this ancient lake, which has been called Bonneville after the noted trapper, you would find two low spots in the mountains which hem the waters in, one upon the south, facing the Colorado River, the other on the north toward the Snake River. The one on the north happened to be a little lower, so that the break occurred there. First as a little, trickling stream, then as a mighty, surging river, the water poured northward down the valley of a small stream, widening and deepening it until, passing the spot where now the town of Pocatello stands, it joined the Snake River.

This old outlet is now known as Red Rock Pass, and it forms an easy route for the Oregon Short Line from Salt Lake City to the plains of southern Idaho. The old river-bed is marked by marshes and fertile farms.

With an outlet established, Lake Bonneville could rise no higher, and its waves began the formation of a well-defined terrace or beach, just as waves are sure to do along every shore. The level of the water could not remain permanently at the same height, for the rocks at the outlet were being worn away by the large volume of water which flowed over them. In the course of years the level of the lake was lowered four hundred feet. The sinking was not uniform, but took place by stages, while at each period of rest the waves made a new beach line. The lake during all this time must have been a beautiful sheet of fresh water filled with fish. Its shores, also, must have been much richer in vegetation than they are now.

The water remained for a long time at the level of four hundred feet below its highest stage. This fact is evident from the width of the wave-cut terrace, which is the most prominent of all those that mark the old levels along the sides of the mountains. Finally, for some reason the climate began to change, the streams supplied less water to

FIG. 54. — RED ROCK PASS, SOUTHERN IDAHO
Outlet of Lake Bonneville

the lake, and the evaporation from its surface became greater because the air was drier. As a result the lake was lowered to such an extent that it lost its outlet. The mighty river flowing down through Red Rock Cañon grew smaller and at last dried up altogether.

In this manner the lake was again cut off from the

ocean, as it had been during its earlier history. The waters still continued to recede, but not at a uniform rate. During periods of greater rain its level remained stationary, so that the waves added new terraces to those already formed.

As the lake had no outlet and was decreasing in volume, the water became salty, for the minerals brought by the streams could no longer be carried away. The fish either died or passed up into the purer waters of the inflowing streams.

The water of the present lake is so salt that in every four quarts there is one quart of salt, and the preparation of this commodity by a process of evaporating the water in ponds has become an important industry. The water is the strongest kind of brine and it is impossible for a bather to sink in it. One floats about upon it almost as lightly as wood does upon ordinary water. After bathing it is necessary to wash in fresh water to remove the salt from the body.

The dry bed of the former Lake Bonneville stretches far to the south and west of the present lake, and forms one of the most barren and arid regions in the United States. It is sometimes called the Great American Desert.

Why is the lake receding now? Some people think that the climate is growing still more arid, and that the lake will eventually disappear. Others think that its shrinkage is the result of irrigation, for a large part of the water from the streams which supply it is now taken out and turned upon the land. There is still another reason which may account for the low water. The lake is known to rise and fall during a series of wet and dry years. When first

mapped, in the middle of the last century, it was about as low as it is now. Then it gradually rose for a number of years and lately has again been falling.

The story of Great Salt Lake has been much more complicated than the statement given above, but this is sufficient for our purpose.

Irrigation has made a garden spot of a large part of the old bed of Lake Bonneville, but much of the beauty and attractiveness of this region would be lost if the present lake should give place to a bed of glistening salt. Let us hope that it will remain as it is.

THE SKAGIT RIVER

THE Skagit is not one of the great rivers of the world, for very little of its course lies outside the boundaries of a single state. It is, however, none the less interesting. Few rivers with a length of only one hundred and fifty miles present so great a variety of instructive features. We shall certainly learn more from a study of the Skagit than from many a better known and more pretentious river.

Innumerable torrents, fed by the glaciers of the Cascade Range, pour down the rocky slopes and lose themselves in the wooded cañons below. The cañon streams, of much greater size, flow less impetuously over gentler slopes, and are frequently blocked by boulders and logs. These streams unite in one broad, deep river, which moves on quietly to its resting-place in Puget Sound. Its name, Skagit, is of Indian origin and means *wild cat.*

By following the Skagit River and a tributary stream, one can go from the bare and snowy summit of the Cascade Range down through dense forests, and come out at last upon a magnificent delta, where a fertile plain is slowly but steadily encroaching upon the waters of the sound. What contrasting scenes are presented along the few short miles of the course of the river! A trip from its source to its mouth will be worth all the trouble it involves, although the trail is often disagreeably wet and sometimes dangerous.

There is no grander scenery in the United States than that of the Cascade Range; nor are there more dense forests than those found upon its western slope. The range is hidden in almost perpetual clouds and storms, and they are fortunate who can reach its summit upon a pleasant day.

FIG. 55. — SUMMIT OF THE CASCADE RANGE, NEAR THE HEAD OF THE SKAGIT RIVER

The forests of fir and hemlock have gained a foothold nearly to the summit of the range. Upon the little benches and in the protected nooks the trees grow thriftily, and dense groves are found up to an elevation of nearly five thousand feet; but upon the more exposed and rocky slopes stunted trunks show the effect of a constant struggle with the rocks and winds. Upon other slopes, too high

for the trees to grow, there are low shrubs and arctic mosses; but above all rise precipitous crags and peaks, utterly bare except for the glaciers nestling among them.

Under the shade of the upland forests the moss is damp and the wood wet, so that it is difficult to make a comfortable camp or to build a fire. But these discomforts are not worthy of consideration in view of the inspiration which one gains by the outlook from some commanding point upon the summit of the mountain range.

All about are jagged, splintered peaks. Upon every gentle slope there rests, within some alcove, a glistening mass of snow and ice. A score of these glaciers are in sight. They are supplied in winter by the drifting snows, and yield in summer, from their lower extremities, streams of ice-cold water. A multitude of streams raise a gentle murmur, broken occasionally by a dull roar as some glacier, in its slow descent, breaks upon the edge of a precipice and its fragments fall into the cañon below.

From a position upon the summit above the point where the Skagit trail crosses the mountains may be seen a little lake, on the surface of which remains some of last winter's ice not yet melted by the August sun. If the climate were a little colder, the basin would be occupied by a glacier instead of a lake. All about the lake there are steep, rocky slopes, more or less completely covered with low arctic plants and stunted, storm-beaten hemlocks. From among the trees at the foot of the lake rises the roof of a miner's log cabin, and a few hundred feet beyond a small, dark opening in the face of a cliff shows where the miner is running a tunnel in his search for gold.

Far below, and heading close under the sharp crest of the range, are densely wooded cañons. The fair weather

is passing, and it is necessary to find the trail and descend. Clouds are sweeping across the ridges and peaks, and soon the whole summit will be covered by them.

From a point a little east of the summit the clouds present a grand sight at the gathering of a storm. Higher and higher they pile upon the ocean face of the mountains. At the bottom they are dark and threatening, but the thunder-heads above can be seen bathed in the bright sunlight. For a time the clouds hang upon the summit as if stopped by some invisible barrier; perhaps they are loath to pass into the drier air of the eastern slope. But finally they move on, and rain or snow soon envelops the whole landscape.

The trail descends rapidly for four thousand feet to Cascade River, a tributary of the Skagit. It is a steep and slippery way, and in many places it is not safe to ride the horses. The sub-arctic climate of the summit is left behind, and one is soon surrounded by dense and luxuriant vegetation. Such a change as this, in a short distance, shows how greatly elevation affects climate and plant growth.

Upon every hand there is the sound of rushing water. From the cliffs ribbon-like cascades are falling. The rivulets unite in one stream, which roars and tumbles down the cañon over logs and boulders. The trail crosses and recrosses the torrent until the water becomes too deep for fording, and then it leads one to a rude bridge made of two logs with split planks laid across them.

As the cañon widens, the trail leads farther from the river and through dense forests. The woods are so silent that they become oppressive, and the air is damp, for the sunlight is almost excluded. The tall trees, fir, hemlock, and spruce, with now and then a cedar, stand close to-

gether. Shrubs of many kinds are crowded among them, while mosses and ferns cover the ground. The fallen trunks are wrapped in moss, and young trees are growing upon them, drawing their nourishment from the decaying tissues. In the more open spots grow the salal bushes with their purple berries, the yellow salmon berries, and the blue-black huckleberries.

It is difficult to get an idea of the density of a Washington forest, or of the character of the streams, unless one has actually taken a trip through the region. If one wishes to escape the forest by following the streams, he will find the path blocked by fallen trees. It is necessary continually to climb over or under obstructions, and the traveller is fortunate if he does not fall into the cold water. Upon the banks it is even worse; one must struggle through dense prickly bushes and ferns, and be tripped every few rods. Though the forest may appear at first to offer an easier way, it will soon be found that creeping and crawling through the undergrowth of bushes and young trees is exceedingly tiresome, and one will gladly return to the muddy trail, thankful for its guidance.

The mountains become less precipitous and the cañon widens to a valley, until at last the trail comes out at a clearing where the Cascade River joins the Skagit. At this point, known as Marble Mountain, there is a ferry, also a store and several other buildings. The cleared fields seem a relief after many miles of dense forest, but such openings are infrequent, for few settlers have yet pushed far into the forests of the Skagit valley. To make a clearing of any size, tear out the stumps, and prepare the land for cultivation, requires many years of hard labor.

How silently and yet with what momentum the river sweeps on! The water is clear in summer, but in winter it must be very muddy, for the Skagit is building one of the largest deltas upon Puget Sound.

FIG. 56. — SKAGIT RIVER IN ITS MIDDLE COURSE

At Marble Mountain the traveller may, if he wishes, leave his horses, hire an Indian canoe, and float down the river to the nearest railroad station. The ride in the cedar canoe, with an Indian at the stern carefully guiding it past snags and boulders, is one of the pleasantest portions of the trip. The winding river is followed for nearly fifty miles. There is mile after mile of silent forest, the solitude broken only here and there by camps of Indians who are spending the summer by the river, fishing and picking huckleberries. Now and then a call comes from one of

these camps, and in spite of the danger of being swamped by the swift current, the canoe is turned toward the shore, but the stop is only for a moment.

At last a new railroad grade comes in sight, with gangs of men at work. The valley of the Skagit contains one of the finest bodies of timber in Washington, and the railroad is being built for the purpose of reaching this timber. There is little other inducement for the building of a railroad; for beside a few summer visitors, the only inhabitants are the scattered prospectors and miners.

We enter the train at a little town in the woods and are soon speeding down the valley toward the mouth of the river. Clearings appear in the forest, and at last the view opens out over extensive meadows which stretch away, almost as level as a floor, to the waters of the sound. Here and there the meadows are broken by forest trees or irregular groups of farm buildings. Rich lands form the delta of the Skagit River. The value of these natural meadows was quickly recognized by the early settlers, for not only was the land exceedingly fertile, but it did not have to be cleared in order to be transformed into productive grain-fields.

For centuries, ever since the melting of the great glaciers which once descended the Cascade Range and crept down the sound, the river has been building this delta. It grew rapidly, for immense accumulations of gravels and clays were left by the retreating glaciers. The delta has already spread westward into the sound, until it has enveloped some of the smaller islands. The forests growing upon these islands, which rise from the surface of the delta plain, are in picturesque contrast to the fields dotted with stacks of grain.

The delta is now practically joined to the eastern side of the San Juan Islands. The railroad reaches the islands by means of a trestle across the intervening tidal flats, delivering its load of logs at the mills and leaving the passengers at the town of Anacortes, where they may take one of the many steamers passing up and down the sound.

FIG. 57.—THE DELTA OF THE SKAGIT RIVER
Enveloping former islands in Puget Sound

Of all the deltas now forming about Puget Sound that of the Skagit is the largest and most interesting. One might think that the forests would so protect the slopes that erosion would not be rapid, but the valleys of all the tributary streams appear deeply filled with rock fragments, which have, for the most part, accumulated

from the higher portions of the range, where frost and ice are slowly tearing down the cliffs. At each period of flood some of this material is passed on to the river, which in turn drops it upon the borders of its delta.

The Skagit River, from its source to its mouth, takes the traveller through varying climates and life zones, from the barren crest where the miner is the only inhabitant, down through forests where the lumberman is busy, until it leaves him upon the rich meadows of its delta.

THE STORY OF LAKE CHELAN

CHELAN is the largest and most beautiful of our mountain lakes. The lake itself is most attractive, and the basin in which it lies has had an interesting history, so that it is well worth study.

Notwithstanding the beauties of this lake, it is not widely known, for it is situated far away from the main lines of travel, in a remote cañon of the Cascade Range. Fortunately the lake and the rugged mountains about it have been included in a forest reserve, so that they will be kept in all their wild natural beauty.

The Columbia River, in its crooked course across the state of Washington, follows for some distance the junction of the vast treeless plateau of the central portion and the rugged, forest-clad slopes of the Cascade Range. We have already learned how the plateau grew to its present extent through the outpouring of successive floods of lava which swept around the higher mountains like an ocean.

Many cañons furrow the eastern slope of the Cascade Range, and terminate in the greater cañon of the Columbia at the edge of the lava. One of these cañons, deeper and longer than the rest, has been blocked by a dam at its lower end. Beautiful Lake Chelan lies in the basin thus formed. It begins only three miles from the Columbia River, but winds for sixty miles among the rugged and steep-walled mountains, terminating almost in the heart of the range.

The lake can be reached either by crossing the mountains from Puget Sound, over a wet and difficult trail, or by ascending the Columbia River from Wenache, the nearest railroad station. The trip can be made from the latter point either upon the stage or river steamer. The wagon road is very picturesque, winding now under lofty cliffs with the river surging below, now along the occasional patches of bottom land where in July the orchards are loaded with fruit.

The first sight of Lake Chelan is disappointing, for at the lower end, where the wagon road stops, there is little to suggest the remarkable scenery farther back in the mountains. Rolling hills, covered with grass and scattered pine trees, slope down to the lake, while here and there farmhouses appear.

One cannot help asking at the first view what there is about Lake Chelan which has made it, next to Crater Lake, the most noted body of water upon the Pacific slope of the continent. But wait a little. Either hire a rowboat and prepare with blankets and provisions for a camping trip about the shores; or if the time is too short for carrying out that plan, take the little steamer which makes tri-weekly trips to the hotel at the head of the lake. Long before you reach the upper end you will begin to appreciate the grandeur of the lake scenery in its setting of steep-walled mountains.

Little of Lake Chelan can be seen at one time, for its course among the mountains to the west is a very crooked one. The noisy steamer leaves the town at the foot of the lake and in the course of ten miles steeper slopes begin to close in upon us. Many little homes are scattered along this portion of the lake, wherever there is a bit of land level enough to raise fruit and vegetables.

Now the mountains become more rugged and rise more steeply from the water's edge. The steamer is very slow; it takes all day to make the sixty miles, but no one is sorry. Occasionally the whistle is sounded and the boat heads in

FIG. 58. — LOOKING DOWN ON LAKE CHELAN

toward the land, where some camping party is on the lookout for mail or a supply of provisions.

The lake averages less than two miles in width, and seems all the narrower for being shut in between gigantic mountains. For some miles we pass under the precipitous cliffs of Goat Mountain, where formerly numerous herds of mountain goats found pasturage.

At every bend in the lake the views become more grand

and inspiring. Here is a dashing stream, roaring in a mad tumble over the boulders into the quiet lake — a stream which has its source perhaps a mile above, in some snow-bank hidden from sight by the steep, rocky walls. Next a waterfall comes into view, pouring over a vertical cliff into the lake. Occasionally snow-clad peaks appear, but only to disappear again behind the near mountains. What pleasant spots we notice for camping by the ice-cold streams! They are full of brook trout, while larger fish are to be found in the lake.

At the head of this body of water there is a little hotel for the accommodation of visitors, and the Stehekin River, which is steadily at work filling up the lake, hurries past its doors. Since the melting of the glacier which once filled the cañon, the river has built a delta fully half a mile out into the water.

The lake has the appearance of filling an old river valley or cañon. Perhaps the latter is the better name because the bed is so narrow and deep. This cañon winds among the mountains just like other cañons in which rivers are flowing, but it has no outlet at the present time. In some way a dam has been formed, and the cañon, filling with water to the top of the dam, has become a lake.

Soundings have shown that the water is fourteen hundred feet deep; that is, a little more than a quarter of a mile. With the exception of Crater Lake, in Oregon, this is the deepest body of water in the United States. It is also interesting to note that the bottom of the lake is fully three hundred feet below the level of the ocean.

How could a river cut a channel for itself so far below the ocean level? Rivers cannot do work of this kind unless they have a swift current; moreover, as they empty

into the ocean, their beds must be above sea level. Some people think that the great glacier, which certainly at some time occupied the depression in which the lake lies, dug out the cañon. This glacier was over three thousand feet in thickness, for the rocks are grooved and polished to a height of nearly two thousand feet above the surface of

FIG. 59.—GOAT MOUNTAIN, NORTH SHORE OF LAKE CHELAN

the water. It is, nevertheless, improbable that the glacier did anything more than deepen and widen the cañon somewhat. It was certainly made, as we at first supposed, by a river which flowed through it at some remote period. At that time the land of our Pacific coast must have stood many hundred feet higher than it does now.

The surface of Lake Chelan is a little more than three hundred feet above the bed of the Columbia River, which

flows through a deep cañon only three miles distant. If we could remove the dam of glacial boulders and gravel at the lower end of the lake, the water would be lowered only three hundred feet. The lake would not be drained, for it is very much deeper. Now here is another puzzle for us: the bottom of the lake is more than one thousand feet below the level of the Columbia. We shall have to go still farther back into the past to get a satisfactory explanation this time.

Hundreds of thousands of years ago there was no plateau filling central Washington, and no Columbia River crossing it. The Cascade Range stood where we see it to-day, and the region of the plateau was a broad valley, toward which flowed the streams that had already cut cañons upon the eastern side of the range. These streams probably united in a river emptying westward into the Pacific by a course now unknown. The shores of the ocean were farther west than at present, for the land stood higher.

The cañon of Lake Chelan was made by a river of this period, which through many long years gradually deepened and enlarged its channel. The river worked just as we see rivers working at the present time, for throughout all the history of the earth rivers have not changed their habits. Then came the long period of volcanic eruptions. Our Northwest was flooded by fiery lava, which built up the Columbia plateau and buried under thousands of feet of rock the old river valley into which the cañon of Chelan emptied.

Then streams of water began to flow over the plateau from the higher mountains above the reach of the lava. These streams formed the Columbia River, which sought

the easiest way to the sea, and finally excavated a cañon for hundreds of miles. In a portion of its course the river came close to the edge of the Cascade Range. The ancient cañon of Lake Chelan had been dammed up by the lava, and a lake occupied a portion of the former bed of the

FIG. 60. — LOOKING DOWN LAKE CHELAN FROM THE UPPER END

river. The Columbia could not cut its channel deep enough to drain the lake, and there it remained.

Then another change came: the climate grew cold and heavy snows gathered upon the Cascade Range. The snow did not all melt during the summers, but went on increasing from year to year. The masses of snow moved gradually down the mountain slopes, growing more and more icy until they became true glaciers.

In this manner it came about that a river of ice occupied the cañon in which the old lake lay, and, displacing its waters, scraped and ground out the bottom and sides. The moving ice deposited the waste material at the lower end of the cañon, where it joined the Columbia River, the cañon of which was also occupied by a glacier coming from farther north. When the glacier began to retreat up the Chelan cañon, it left a great mass of rock débris, forming a dam between its basin and the Columbia. After the ice had disappeared, water collected in the cañon above the dam, and the narrow, deep lake was formed, enclosed within granite walls.

As the snows melted, forests spread over the mountains, the bear, deer, and mountain goats came back again, while the streams, bringing down earth and rocks, began their work of filling up the lake. This task they will succeed in accomplishing some day unless something unforeseen happens to prevent. A valley, composed partly of meadow and partly of boulder-covered slopes, will then have taken the place of the lake.

THE NATIVE INHABITANTS OF THE PACIFIC SLOPE

The explorers and early settlers found a native race occupying nearly every portion of our continent. These people had many characteristics in common and were all called Indians. It is believed that they came originally from Asia, but their migration and scattering occurred so long ago that they have become divided into many groups, each having its own language and customs.

In the western portion of the country, where the surface is broken by numerous barriers, such as mountains and deserts, almost every valley was found to be occupied by a distinct group of Indians called a "tribe." The language of each tribe differed so much from the languages of adjoining tribes that they could with difficulty understand one another. These tribes were almost continually at war.

The Indians upon the Pacific slope were generally found to be inferior in most respects to those living in the central and eastern portions of the continent. One might suppose that the tribes possessing the fair and fertile valleys of California would be the most advanced in civilization, but such was not the case. Many of them were among the most degraded upon the continent. They seemed unable to adapt themselves to the white man and his ways, and in the older settled districts they have now nearly disappeared. In the newer portions of the

Northwest and along the coast toward Alaska the Indians have not yet come into so direct contact with the white men, and remain more nearly in their primitive condition.

When the Indians of central California were first seen, they wore but little clothing, and knew how to construct only the simplest dwellings for protection from the weather. They did not cultivate the soil, nor did they hunt a great deal, although the country abounded with game. Along the larger streams fish was an important article of food, but in other places, acorns, pine nuts, and roots constituted the main supplies. The acorns were ground in stone mortars and made into soup or into a kind of bread. These Indians have often been called Diggers because they depended so largely for their living upon the roots which they dug.

It would seem natural that about San Francisco Bay the natives should have used canoes, but, according to early travellers, they had none. When they wished to go out upon the water they built rafts of bundles of rushes or tules tied together.

At favorable points along the shore the Indians collected for their feasts, and these spots are now indicated by heaps of shells, in some places forming mounds of considerable size. Many interesting implements have been dug from these mounds, or kitchen middens as they are sometimes called. In the mountains the sites of the villages are marked by chips of obsidian (a volcanic glass used in making arrow-tips) and by holes in the flat surfaces of granitic rocks near some spring or stream. These holes were made for the purpose of grinding acorns or nuts.

Many of the Indian tribes developed great skill in the weaving of baskets, which they used for many different

purposes. The baskets are still made in some places, and are much sought after because of their beauty.

The Indians of northern California in building their homes dug round, shallow holes, over which poles were bent in the form of a half-circle, and then tied together at the top. Bark was laid upon the outside, and earth was thrown over the whole structure.

FIG. 61. — HOLES IN ROCK, MADE FOR GRINDING FOOD

"Sweat houses" were built in much the same manner, and were used chiefly during the winter. When an Indian wished to take a sweat, hot stones were placed in one of these houses, and after he had entered and all openings were closed, he poured water upon the stones until the room was filled with steam. After enduring this process as long as he desired, the Indian came out and plunged into the cold water of a near-by stream. As may be imagined, such a bath often resulted disastrously to the weak or sick.

The fact that the California Indians could support themselves without any great exertion undoubtedly had the effect of making them indolent, while in the desert regions of the Great Basin the struggle for something to eat was so severe that it kept the natives in a degraded condition.

FIG. 62. — CALIFORNIA INDIAN BASKET

The Indians of the Columbia basin built better houses than those farther south. Where wood was abundant their homes were similar in some respects to those of the coast Indians north of the mouth of the Columbia. Fish was their main article of diet. At certain seasons of the year, when salmon were plentiful, each tribe or group of Indians established its camp near one of the many rapids and waterfalls along the Columbia River. Large numbers of the salmon were caught by the use of traps. After being partly dried they were packed in bales for winter use. The fish thus prepared were considered very valuable and formed an article of trade with the tribes living farther from the river.

The Indians inhabiting the coast northward from the mouth of the Columbia were different in many respects from those farther south or inland. They built better homes, took more pains with their clothing, were skilled in the making of canoes, and showed marked ability in navigating the stormy waters of the channels and sounds.

FIG. 63. — HESQUIAT INDIAN VILLAGE
Nootka Sound, Vancouver Island

The Vancouver Island Indians are called Nootkas, from the name of an important tribe upon the west coast. Those of Queen Charlotte Islands, still farther north, are known as Haidas. These two groups are very similar. They live upon the shores of densely wooded, mountainous lands and travel little except by water. Some of the canoes which these tribes construct are over fifty feet long and will easily carry from fifty to one hundred persons. Such a canoe is hewn out of a single cedar log, and presents a very graceful appearance with its upward-curving bow. In these boats the Indians take trips of hundreds of miles.

FIG. 64. — FLATHEAD INDIAN WOMAN, VANCOUVER ISLAND

A ride in one of the large canoes is an interesting experience. When a party starts out to visit the neighboring villages, carrying invitations to a festival, the men are gayly dressed, and shout and sing in unison as they ply their paddles. The great canoe jumps up and onward like a living thing at every stroke of the paddles, which are dipped into the water all at once as the rowers keep time to their songs. But this enthusiasm quickly disappears if a head wind comes up, and the party goes ashore to wait for the breeze to turn in a more favorable direction.

These Indians, as might be supposed, live largely upon fish. Berries are abundant during the summer and are

also much used for food. The clothing of the Indians was originally a sort of blanket made of the woven fibres of cedar bark, or more rarely, of the skins of animals, although among the northern tribes skins were used almost exclusively. Matting made of the cedar bark is still in common use in their houses.

FIG. 65. — INDIAN HOUSES, FORT RUPERT, VANCOUVER ISLAND

Among the Vancouver Island Indians, a few have peculiarly flattened foreheads (Fig. 64). This deformity is produced by binding a piece of board upon the forehead in babyhood and leaving it there while the head is growing.

The villages are located in some protected spot where the canoes can lie in safety. The buildings are strung

along the shore close under the edge of the thick forest and just above the reach of the waves at high tide. They are very solidly constructed, for these Indians do not move about as much as those farther south where the forests are less dense. Figure 65 shows the framework of a partially built house, while another stands at one side completed. Large posts are set in the ground at the corners and ends of the building; cross logs are then placed upon the middle posts, and upon these a huge log is placed for a ridge-pole. This is sometimes two feet in diameter and from sixty to eighty feet long. It must require the united strength of many men to roll such a log into position. Upon the framework thus constructed split cedar boards are fastened, and the building is practically finished. Such a house is usually occupied by a number of families. Upon Queen Charlotte Islands there is a dwelling of this kind large enough to hold seven hundred Indians.

The fronts of the houses are ornamented with figures hewn out of wood. These represent men, birds and animals and have a religious significance. Sometimes these figures are mounted upon the tops of tall poles.

The "totem pole" is a most interesting affair. Figure 66 represents the pole at Alert Bay, east of Vancouver Island. It is one of the finest upon the north coast. The figures of animals and birds carved upon it represent the mythological ancestors of the family or clan in front of whose abode the pole stands. The Indians often hunt similar animals to-day, but believe that their ancestors had supernatural power which raised them above the ordinary creatures.

The Chinook Indians live upon the lower Columbia. The name "chinook" has been given to a warm, dry

wind which blows down the eastern slope of the Rocky Mountains and out upon the Great Plains. This wind is so named because it blows from the direction of the Chinook Indians' country. The "Chinook" jargon is a strange sort of mixed language with which nearly all the tribes of the Northwest are familiar. It is formed of words from the Chinook language, together with others from different Indian languages, French-Canadian, and English. Through the influence of the trappers and traders the "Chinook" has come into wide use, so that by means of it conversation can be carried on with tribes speaking different languages.

FIG. 66. — TOTEM POLE
Alert Bay, British Columbia

Although there are so many different tribes, with great diversities of language, throughout the West, they were probably all derived from the same source. As we go north the similarity between the coast

Indians and the inhabitants of eastern Asia becomes more noticeable. It seems almost certain that these American Indians originally came across the narrow strip of water separating Asia from America.

We do not know how long the Indians have occupied our country, but it has probably been several thousand years. Some of the main groups have undoubtedly been here longer than others.

Unless we protect the Indians and permit them so far as possible to lead their own natural lives, most of them will soon disappear.

THE STORY OF LEWIS AND CLARK

In the seventeenth century it appeared likely that France would before long control the northern and interior portion of North America. La Salle discovered the Ohio River, traversed the Great Lakes, and descended the Mississippi River to its mouth. In 1742 other French explorers pushed west from the Great Lakes and sighted the Rocky Mountains. But when the English triumphed at Quebec, France gave up to them all of her possessions east of the Mississippi River, and ceded the province of Louisiana to the Spanish. This province was very much larger than the state which now bears the name. Bounded by the Mississippi River upon the east, and the Spanish possessions upon the southwest, it stretched north and west with very indefinite boundaries, although in the latter direction it was supposed to be limited by the Rocky Mountains.

At one time Napoleon dreamed of founding a great colony in America, and induced Spain to cede Louisiana back to the French; but being unable to carry out his plans, he made a proposition to the United States to take this territory. His offer was accepted, and in 1803, during the presidency of Thomas Jefferson, the vast province was taken into the Union.

It was immediately evident that more definite knowledge should be acquired concerning the great region beyond the Mississippi, particularly the portion about the head of the Missouri River. The unknown region lying between

the source of this river and the Pacific should also be explored, for Captain Gray's discovery of the Columbia River gave to the United States a claim upon this part of the continent which must be maintained. If something were not done soon, the territory would be occupied by the English fur companies.

Two young men, Captains Lewis and Clark, were chosen to lead an expedition into the Northwest, which proved to be one of the most remarkable in the history of our country. They were the first white men to cross the Rocky Mountains and to traverse the continent from the Atlantic to the Pacific within the present boundaries of the United States.

How interesting it must have been to push into the Rocky Mountains, beyond the farthest point previously reached by white men; to see Nature in her wild state, to note the new plants and animals, and to study the Indians before their contact with Europeans had changed their customs!

Lewis and Clark were particularly instructed to investigate the sources of the Missouri, to learn how the continental divide could be crossed, and to ascertain the nature of the streams which flowed westward to the Pacific. They were also to study the resources of the country, and to examine into the character and customs of all the Indian tribes that they should meet.

The start was made from St. Louis in May, 1804, with two large rowboats and one sail-boat. The latter was to return with news of the party when the farthest outpost upon the Missouri was reached.

Through the summer months and late into the fall the boats toiled up the river against the swift current, finally

reaching a village of the Mandan Indians in the present state of North Dakota, where the explorers spent the winter. Thus far they were in a region frequently visited by the traders and trappers from St. Louis.

FIG. 67. — THE GREAT FALLS OF THE MISSOURI

In the spring they pushed on again in canoes, at length entering an unknown region. The Missouri forked so frequently that it was often difficult to determine which was the main stream. To the surprise of the travellers, the country appeared to be uninhabited, so that they could get no assistance from the Indians. Only a small stock of provisions remained, and as the party numbered about thirty, it was necessary to keep hunters out in advance all the time.

As we are carried swiftly through this region to-day in the cars, no signs of wild creatures are to be seen, and it is difficult for us to believe that game was once abundant. The narrative of the expedition abounds with descriptions of various large animals which the explorers met in herds, such as deer, antelope, buffalo, bears, and wolves. The bears, both white and brown, were very numerous and bold. The white bears in particular were so ferocious that the hunters had many serious encounters with them. They would sometimes enter the camp at night, and at one time a herd of buffalo stampeded through it.

When undecided at one point which branch of the river to follow, Captain Lewis went some distance in advance and discovered the Great Falls of the Missouri. He was greatly impressed and awed by the magnitude and height of the successive falls, which were twenty-four, forty-seven, and eighty feet high respectively, and were connected by a series of cascades.

Many days were spent there in a long and laborious portage, for everything had to be carried a distance of twelve miles before the quiet water above the falls was reached.

How the coming of the white man has changed the region about the falls! The game has disappeared; an important city, supported by the enormous water-power, is growing up; while the smoke rising from extensive plants for reducing the gold, silver, and copper ores mined in the Rocky Mountains floats out over the country.

Proceeding up the river, the party reached the Gate of the Mountains — a picturesque spot where the stream leaves the mountains through a narrow defile between high and jagged cliffs and enters upon its long course across

the Great Plains (Fig. 68). Gradually the river became smaller, and at last the travellers came to the point where it divided into three branches, to which they gave the names of Gallatin, Madison, and Jefferson forks. The

FIG. 68. — THE GATE OF THE MOUNTAINS
The Missouri River at the entrance to the Rocky Mountains

party made their way up the latter fork, which flowed from a westerly direction.

Now they began to look anxiously for the Indians, from whom it would be necessary to get horses to transport their baggage when the river should become too small for the canoes. This region was inhabited by the Shoshones. It may well be asked how it happened that these Ind-

ians had horses, since no white people had ever visited them before. Their purchase of horses came about through the processes of trade with the tribes to the south, who in turn came in contact with the Spanish of New Mexico.

One or the other of the leaders kept in advance, on the lookout for the Indians. At last Captain Lewis, while crossing the divide at the head of the stream which they had been following, came suddenly upon several Indians. After overcoming their fear by presents, he accompanied them to their camp and induced them to return with horses to assist the party.

Upon reaching the Pacific side of the continental divide the explorers were in doubt as to which way to proceed. No man had been before them, and the Indians told stories of fearful deserts to the southwest (probably the Snake River plains), and said that the mountains were too steep for the horses, and the rivers too rapid for canoes.

If you will examine a map of the country about the head of the Jefferson fork of the Missouri, you will not wonder that Captains Lewis and Clark were in doubt as to which way they should go in order to reach the Columbia. They first attempted to go down the Salmon River, but soon gave up this project. They turned about and crossed the mountains to the Bitter Root River, which flows north and empties into Lake Pend d'Oreille through Clark's Fork of the Columbia.

After going down the Bitter Root for a short distance they turned west again across the Bitter Root Mountains and came out upon the head waters of the Kooskooskie River. Unable to follow its cañons, they wandered to the

north among the mountains. At this time their sufferings were intense. Food became so scarce that they were obliged to eat their horses. After many weary days they again reached the stream, but this time at a point where it was navigable. They floated down to its junction with the

FIG. 69. — CELILO FALLS, COLUMBIA RIVER

Lewis or Snake River, where the growing city of Lewiston now stands. At this point they met the Nez Percés Indians, who assisted them in every possible way.

The party continued down the Snake River in canoes until they finally reached the Columbia. The difficulties of navigation were great, for at intervals of every few miles the river was broken by rapids through which it was

dangerous to take the canoes. By treating the Indians kindly, the party succeeded in trading with them for such articles of food as horses and dogs. They also obtained some salmon. The presence of this fish in the streams gave them the first assurance that the Pacific slope had been reached. Along the Columbia River salmon was one of the chief articles of food for the Indians.

At Celilo Falls, a short distance above the present city of The Dalles, the travellers found great difficulty in proceeding, as the canoes and loads had to be carried, or "portaged," around the falls. Lewis and Clark called these the Great Falls of the Columbia (Fig. 69).

As the canoes floated down through the magnificent cañon by which the Columbia passes the Cascade Range, they encountered another rapid, now known as the Cascades of the Columbia. This rapid is due to a great landslide which has formed a dam across the river. Captain Lewis speaks of the broken trunks of trees rising from the water above the dam, a fact which would lead one to suppose that it had not been very long since the slide occurred.

Below the Cascades the party soon began to notice the influence of the tides in the rise and fall of the river, and knew then that the Pacific could not be very far away. Early in November they came in sight of the ocean, and in a few days had the pleasure of standing upon its shores. The long and dangerous trip of four thousand miles had been completed without any serious accident.

Continual rains poured upon them, and before winter quarters could be prepared they were in a very uncomfortable position. A permanent camp was selected upon the Oregon side of the Columbia, and log buildings were

erected. The camp was called Fort Clatsop. While in their winter quarters the party cultivated friendly relations with the Indians, and made extensive notes upon their habits and characteristics.

In the spring, since no ship had appeared which would carry them back by water, Lewis and Clark determined to return overland. First, however, they left some records

FIG. 70. — THE CASCADES OF THE COLUMBIA
A steamer going up to the locks

with the Indians, with directions that these should be given to the captain of any ship which might happen to visit the mouth of the Columbia. The leaders wished to make sure that if anything happened to the party the knowledge gained by their explorations should not be lost.

One can imagine with what pleasure the men turned homeward. Although they had started with flour, rice,

corn, and other articles of food, these had given out long before they reached the lower Columbia, and for some months their only diet had been fish and the animals that the hunters had killed. Their stock for trading with the Indians was also nearly gone; all the articles that were left could be put into two pocket handkerchiefs.

After ascending the Columbia River to a point above The Dalles, the party left the stream, as they found that it would be impossible to make much headway with the canoes. Obtaining horses from the Indians, they followed the outward route back as far as the Kooskooskie River. Then they turned north and crossed the mountains to the Missoula River. Near the present city of Missoula the party divided, Captain Lewis going up Hell Gate River and crossing the continental divide to examine the country lying north of the Missouri.

Captain Clark, with another portion of the company, went up the Bitter Root River and over the mountains to the Jefferson Fork, which the whole party had ascended the year before. He followed this river down to its junction with the Gallatin, and travelled for a distance up the latter stream, then crossed by land to the Yellowstone River.

Canoes were constructed upon the Yellowstone, and the party floated down to the junction of this river with the Missouri. There the two bands were fortunately reunited, and together they passed rapidly down the Missouri until they reached the "village" of St. Louis, where the whole population came out to welcome them. As the party had been gone more than two years, it was feared that they would never be heard from again.

There can be no doubt that the expedition of Lewis and

Clark added greatly to the public interest in the vast region which they traversed, and helped to bring about the final retention of the Oregon country. The Hudson Bay Fur Company soon after established trading posts at various points along the Columbia, and kept up their contention that all the country lying north of the river rightfully belonged to England.

It was very remarkable that the Lewis and Clark expedition had made the long journey to the Pacific and back without meeting with serious accident. There were perils to be met on account of the ruggedness of the country, the rapids in the streams, the lack of food, and the danger of attack from the Indians. The successful accomplishment of the plan was without a doubt largely due to the ability of the two brave leaders.

THE RUSSIANS IN CALIFORNIA

How many of us know that the Russians once established a post upon the coast of California and held it for nearly a third of a century? If the geographic conditions about this post had been different, it is possible that the Russian colonists would hold their position now.

The discoveries made upon the North American coast by the Russian navigator, Bering, in 1741, led to fur trading with the Indians; and in 1798 the Russian American company was organized and established its headquarters at Sitka.

The Spaniards still claimed the whole Pacific coast of North America as far north as the Strait of Fuca, though they had given up their station at Nootka Sound, Vancouver Island. They had, however, made no settlements north of the port of San Francisco.

It was nearly one hundred years ago that Rezanof, a leading Russian official, arrived at Sitka and began to investigate the condition of the settlements of the Russian American Fur Company. He found them in a sorry state; the people were nearly starved and most of them were sick with the scurvy. No grain or vegetables were grown along that northern coast, nor could they be supplied from Asia. Rezanof conceived the idea of establishing trade relations with the people of California. By this means furs might be exchanged for the fresh provisions which were so sorely needed in the north.

Rezanof sailed south in 1806 and tried to enter the Columbia River, where the company had planned to establish a settlement, for upon the Russian maps of this time all of the coast as far south as the Columbia was included under Russian jurisdiction. Rezanof was, however, unable to enter the river, probably for the same reason that Meares, the English navigator, had failed to enter. He then proceeded down the coast and finally ran into the port of San Francisco, where he was treated in a fairly polite manner by the Spanish.

After the return of the expedition to the north, definite plans were made for the establishment of an agricultural and trading station on the California coast, as a permanent supply depot for the northern settlements. Rezanof hoped in time to secure a portion of this fair southern land from Spain.

Several hunting expeditions, chiefly made up of Aleut Indians with Russian officers, were sent south and told to keep a sharp lookout for a suitable place to begin operations. In 1809 one expedition entered Bodega Bay, an inlet of some size about sixty miles northwest of San Francisco. This bay, which had been previously discovered and named by the Spaniards, was thoroughly explored two years later.

No good spot for a settlement was found upon this inlet, but in 1812 a location was determined upon, ten miles north of the mouth of the stream we now know as Russian River. There was no good harbor here, simply a little cove, but back of this cove a broad grassy tract formed a gently sloping terrace at the foot of a line of hills. The soil was good and timber was near at hand.

The Russians first made friends with the Indians, who ceded to them the territory in the neighborhood for three

blankets, three pair of breeches, three hoes, two axes, and some trinkets.

In order to protect themselves from possible Indian attacks as well as to be able to hold their position against the Spanish, the Russians constructed a strong stockade. It was made of upright posts set in the ground and pierced with loopholes. At the corners, and a little distance within, were erected two hexagonal blockhouses with openings for cannon. As it happened, however, no occasion ever arose for the use of the ten cannon with which the fort was supplied. The post was given the name Ross, a word which forms the root of the word Russia.

The Spanish, of course, claimed the territory by right of discovery, and watched the work of the Russians with jealous eyes. They were not strong enough to drive the Russians away by force, although they protested more than once against the unlawful occupation of the land. Some trading was carried on between the Russians and the Spanish, and occasionally loads of grain and cattle were sent north.

The number of people at Fort Ross varied from one hundred and fifty to five hundred. The population consisted of Russians, Aleuts, and other Indians. The Aleuts were the hunters and sealers. They spent their time upon the ocean, sometimes entering San Francisco Bay, but usually hunting in the region of the Farralone Islands, which were originally inhabited by great herds of fur seal. There were also otters, sea-lions, and an infinite number of sea-birds. A station was maintained upon the Farralones, where a few men stayed to gather birds' eggs and kill sea-gulls. Many thousands of gulls were taken each year, and every part of their bodies was utilized for some purpose.

FIG. 71. — FORT ROSS FROM THE SEA
Schooner loading wood

Kotzebue, a Russian navigator, whose name has been given to a sound upon northern Alaska, visited Fort Ross and also San Francisco Bay. He considered it a great pity that the Russians had not gained possession of this territory before the Spaniards, for the magnificent bay of San Francisco, in the midst of a fertile country, would have been a prize worth working for.

Year after year the Russian Fur Company sent expeditions to California to trade and bring back provisions. They tried to extend the area under their jurisdiction, but the geographical conditions of the country were unfavorable. The narrow strip of land next the coast was cut off from the interior valleys by mountain ridges and cañons. If the Sonoma Valley had opened westward instead of toward San Francisco Bay, it would have been easy to extend their territory gradually. As it was, the Spanish, who were in control of the bay, had easy access to all of the fertile valleys of central California.

As the sealing industry decreased in importance, and as the maintenance of Fort Ross was expensive, the Russians in 1839 began to consider the question of giving up their post. They finally sold everything at Ross and Bodega, except the land, to Sutter, an American who had acquired a large ranch and established a post or fort at the mouth of the American River. In 1841 the Russians sailed away, never to return. The Spaniards were greatly relieved when this happened, for they had not known how to get rid of their unwelcome neighbors peaceably, and were reluctant to stir up trouble with Russia.

The stockade at Fort Ross has entirely disappeared, but two blockhouses, the little chapel, and the officers' quarters remain as the Russians left them.

Fort Ross is now a pleasant, quiet hamlet. A store and a farm-house have been added to the old buildings. Behind the sloping meadows rise the partly wooded hills, while in front lies the little bay where once the boats of the Russian and Aleut seal hunters moved to and fro.

FIG. 72. — RUSSIAN BLOCKHOUSE, FORT ROSS

Occasionally a small schooner visits the cove for the purpose of loading wood or tan-bark for the San Francisco market.

Fort Ross was never marked by serious strife and seems destined to go on in its quiet way. The blockhouses are rotting and beginning to lean with age, and in time all evidences of the once formidable Russian post will have disappeared.

DEATH VALLEY

To most of us Death Valley is thought of only as a mysterious region somewhere in the Southwest, a place which we are accustomed to picture to ourselves as being the embodiment of everything that is desolate and lifeless, —a region where there is no water, where there are no living things, simply bare rocks and sand upon which the sun beats pitilessly and over which the scorching winds blow in clouds of dust. The reality is hardly so bad as this, for there are living things in the valley, and water may occasionally be found. Nevertheless it is a fearful spot in summer, and has become the final resting place of many wanderers in these desert regions, who having drunk all their water failed to find more.

We have already learned something about the Great Basin: we know that it is made up of vast desert plains or valleys, separated by a few partly isolated mountain ranges. The valleys are peculiar in that they are basins without outlets, and for this reason are known as sinks. Many of the lakes once occupying the valleys are now quite or nearly dry, and the lower portions of their beds are either whitened with deposits of borax and soda, or have been transformed into barren expanses of hardened yellow clay.

The long, gentle slopes about the sinks, which have been built up by the waste rock from the mountains, as a result of the occasional cloudbursts are dotted with sage-brush,

greasewood, or other low plants, and furnish a home for numerous animals.

Back of the gravel slopes rise the mountains, browned under the fierce rays of the summer sun. In some of their deeper cañons little springs and streams are found, but the water usually dries up before leaving the protecting shadows of the cliffs. Toward the mountain tops the desert juniper appears; and if the peaks rise high enough to get more of the moisture of the cooler air, they support groves of the piñon and possibly yellow pine.

The valleys are all much alike. In summer the days are unbearably hot, while in winter the air is cool and invigorating. The skies are overcast for only a few days in the year, but in the autumn and spring fierce winds, laden with dust and sand, sweep across the valleys and through the mountain passes.

Strange rock forms, of many contrasting colors, worn out by wind and water, mark the desert mountains. The granite wears a brown, sunburned coat, while the masses of black lava show here and there patches of pink, yellow, and red. The air is often so wondrously clear that distant mountains seem much nearer than they really are. During the hot summer days the mirage forms apparent lakes and shady groves, illusions which have lured many a thirsty traveller to his death.

Death Valley is the lowest and hottest of the desert basins. Its surface, over four hundred feet below the level of the sea, is the lowest dry land in the United States. The valley is long and narrow and enclosed by mountains. Those upon the east are known as the Funeral Mountains, while upon the west the peaks of the Panamint Range rise to a height of about ten thousand feet.

If the rainfall were greater, Death Valley would be occupied by a salt or alkaline lake, but in this dry region lakes cannot exist, and the bottom of the sink, sometimes marshy after exceptional winter rains, is in many places almost snowy white from deposits of salt, soda, or borax.

Death Valley, then, differs from scores of other valleys in the Great Basin by being a little lower, a little hotter, and a little more arid. Strange as it may seem, old prospectors say that Death Valley is the best watered of all the desert valleys. Since it is the lowest spot in all the surrounding country, the scanty water supply all flows toward it. But the water runs under the gravels of the old river beds instead of on the top, where it might be utilized. Occasionally, however, the water comes to the surface in the form of springs, which are marked by a few willows or mesquite trees and little patches of salt grass.

Long ago, when the rainfall was greater, Death Valley was a saline lake and received a number of streams, two of which were large enough to be called rivers. The Amargoza River, starting from Nevada and pursuing a roundabout way, entered the southern end of the valley. The Mohave River, which rises in the San Bernardino Range, also emptied into the valley at one time, but now its waters, absorbed by the thirsty air and by the sands, disappear in the sink of the Mohave fifty miles to the south.

The summer is the dreaded season in Death Valley. A temperature of one hundred and thirty-seven degrees has been reported by the Pacific Coast Borax Company at the mouth of Furnace Creek. This temperature was recorded in the shade, and is the hottest ever experienced in

the United States. In the sun it is of course much hotter. Many a person has lost his life in trying to cross the heated valley in the middle of a summer day instead of making the journey at night.

Dangerous as this region is, even now when we know so much about it, it was of course much more dangerous

FIG. 73. — ENTERING DEATH VALLEY

for the first white men who entered it. Only those who have had some experience upon the desert can realize the difficulties and dangers which beset the first emigrants who attempted to cross the deserts lying between Salt Lake City and the Sierra Nevada mountains. The story of the sufferings and final escape of that party which, by taking the wrong course, was lost in the great sink, is extremely interesting although sad. The valley received its name from the experiences of the members of this party.

In the latter part of 1849 many emigrants, who had reached Salt Lake City too late in the season to take the usual route through northern Nevada and over the Sierra Nevada mountains, decided that rather than remain in the town all winter, they would follow the south trail across southern Nevada to San Bernardino and Los Angeles.

A party of people finally collected with one hundred and seven wagons and about five hundred horses and cattle. The course led in a southwesterly direction past Sevier Lake and Mountain Meadows in southwestern Utah. In the latter locality the party divided, the larger number leaving the old trail and taking a more westerly direction. They thought in this way to shorten the distance, and hoped, by skirting the southern end of the Sierra Nevada mountains, to gain the San Joaquin Valley in California.

Now trouble began. No one had ever been over the new route, and the location of the springs and the passes through which the wagons could be taken had to be sought out in advance. Soon many of the party turned back to the known trail, but the others continued, though with no knowledge of the nature of the country which they must cross.

Day after day and week after week the slow ox-teams crawled across the broad deserts and over the low mountain ranges. From the top of each successive mountain ridge the men looked with longing eyes toward the west, hoping to get a sight of the snowy Sierras. Finally want of water and food began to weaken the cattle and the wagons were lightened as much as possible.

As the party approached the eastern boundary of California the mountains grew higher and the deserts more

arid. In the clear air the snow-covered peaks of the Panamint Range began to be visible, although one hundred miles away. The weary emigrants believed that these peaks belonged to the Sierra Nevadas, and that beyond them lay the green valleys of California. How great was their mistake! The Panamint Range looks down upon Death Valley with a bold and almost impassable front, while still other broad deserts lie between this range and the real Sierras.

Upon reaching the head of the Amargosa River the party began to separate, for by this time many thought only of saving their lives at any cost. Some followed Furnace Creek to its sink in Death Valley; others went over the Funeral range and came down upon the lower portion of the Amargosa River. In many cases the wagons were abandoned and the oxen were killed for food.

When they came into the sink we now know as Death Valley, the members of the different parties began to feel that they were really lost. From the records that have come down to us we can see that they had not the slightest idea of the direction which they should take or of their distance from the settlements in California. Fortunately it was the winter season and the heat did not trouble them; moreover, the rains and snows furnished some water.

None of the wagons were taken beyond the camp at the western edge of the valley, under the towering peaks of the Panamint Range. This place is now known as Bennett's Wells. Here the wagons were broken up and burned, and the loads, which were now very light, were either taken by the men themselves or placed upon the

backs of the few remaining oxen. It was thought that the fair fields of California would be seen from the top of the Panamint Range; but when the travellers reached the summit other desert valleys appeared in the west, and beyond these, in the dim distance, another snowy range was visible.

The emigrants now divided into parties. One party reached Owens Lake, and turning south, finally passed over the Sierras by the way of Walkers Pass and went down the valley of the Kern River. Another, the Bennett party, including some women and children, remained at the springs in Death Valley, while two of the men started out alone, in the hope of reaching the settlements and returning with food. These men crossed the Panamint Range and struggled on for days in a southwesterly direction, over desert valleys and mountains. They were frequently on the point of giving up in despair for want of food and water.

At last, far to the south, the snowy crest of the San Gabriel Range came into sight. Continuing in a southwesterly direction through the Mohave Desert, the men reached a low pass in the mountains and followed a stream until they came upon a Mexican ranch, where the sight of green meadows, upon which horses and cattle were feeding, delighted their weary eyes.

Several animals were secured and loaded with food. Then the men turned back into the desert. They at last reached the desolate valley again, after an absence of about a month, and found most of the party alive, although nearly driven to despair. With the aid of a mule and several oxen, the party came safely to the fertile valleys near the coast.

Another party, known as the Jayhawkers, struggled on behind the two men who went for relief, and the most of its members also came safely out of the desert, though not without extreme suffering. In all, fourteen people of this expedition perished.

FIG. 74. — SOUTHERN END OF DEATH VALLEY
Showing the white deposits of soda

If you ever have an opportunity to travel over this region, you will wonder that any of the people escaped. The seemingly endless succession of deserts and mountains, the lack of food, and the scanty supply of water, often unfit to drink, would lead one to think that strangers to these wilds would be far more likely to perish than to find their way out.

THE CLIFF DWELLERS AND THEIR DESCENDANTS

The region of the high plateaus of the southwestern United States presents many strange and interesting aspects. Equipped with pack animals for the trails, and conducted by a guide who knows the position of the springs, one might wander for months over this rugged and semi-arid region without becoming weary of the wonderful sights which Nature has prepared.

In travelling over the plateau one has to consider that often for long distances the precipitous walls of the cañons cannot be scaled, and that the springs are few and inaccessible. To one not acquainted with the plateau it appears incapable of supporting human life. There is little wild game and scarcely any water to irrigate the dry soil.

However, if the country is examined closely, the discovery will be made that it was once inhabited, though by a people very different from the savage Indians who wandered over it when the white men first came. These early people had permanent homes and were much more civilized than the Indians. They lived chiefly by agriculture, cultivating little patches of land wherever water could be obtained.

Go in whatever way you will from the meeting point of the four states and territories, Colorado, Utah, Arizona, and New Mexico, and you will find the ruins of houses and forts. Upon the tops of precipitous cliffs, in the caves

with which the cañon walls abound, by the streams and springs, there are crumbling stone buildings, many of them of great extent, and once capable of sheltering hundreds of people. Scattered over the surface of the ground and buried in the soil about the ruins are fragments of pottery, stone implements, corn-cobs, and in protected spots the remains of corn and squash stems.

The people who once inhabited these ruins have been called Cliff Dwellers, because their homes are so frequently found clinging to the cliffs, like the nests of birds, in the caverns and recesses of the precipitous cañon walls. The Cliff Dwellers have left no written records, but from a study of their buildings and of the materials found in them, and from the traces of irrigating ditches, we are sure that they were a peaceful, agricultural people.

The oldest ruins are probably those in the open and less protected valleys. It is evident that after these dwellings had been occupied for an indefinite time the more fierce and warlike Indians began to overrun the plateau region and make attacks upon the primitive inhabitants. These people, peacefully inclined and probably not strong in numbers, could find no protection in the valleys where they irrigated little patches of land and raised corn and squashes; so, retreating to the more inaccessible cañons, they became cliff dwellers. Seeking out the caverns so abundant in these cañons, they went to work with tireless energy to build for themselves impregnable homes and fortresses to which they could retreat when the savage Indians appeared.

The cañon of Beaver Creek in central Arizona contains one of the most interesting of these fortresses, known as Montezuma's Castle. Many small buildings nestle along the sides of the cañon upon the ledges and under over-

hanging rocks, but Montezuma's Castle is the most magnificent of them all, and must have given protection to a number of families.

Halfway up the face of a cliff two hundred feet in height, there is a large cavern with an upward sloping floor and jagged overhanging top. Here with infinite toil the Cliff Dwellers constructed a fortress, the front of which rose forty feet from the foundation and contained five stories. This front was not made straight, but concave, to correspond to the curve of the cliff.

What an effort it must have been for these people, who had nothing but their hands to work with, to quarry the stone. To carry their materials from the bottom of the cañon, by means of rude ladders, up the steep and rugged wall to the foot of the cavern, and then to lay the foundation securely upon the sloping floor, must have been a still harder task.

The stones were laid in mud, and in most cases were also plastered with it. Here and there little holes were left to let in light, but the rooms, with their low ceilings, would have seemed very dismal and dark to us. Beams were set in the walls to support the different floors. Smaller sticks were laid upon the beams, and then a layer of earth was placed over the top.

To pass through the openings between the different rooms the inhabitants had to crawl upon their hands and knees. The places where they built their fires are indicated by the dark stains which the smoke has left upon the walls. Broken pottery and corn-cobs are scattered profusely about the building. How safe these ancient people must have felt in this retreat, where they were protected, both from the storms and from their enemies!

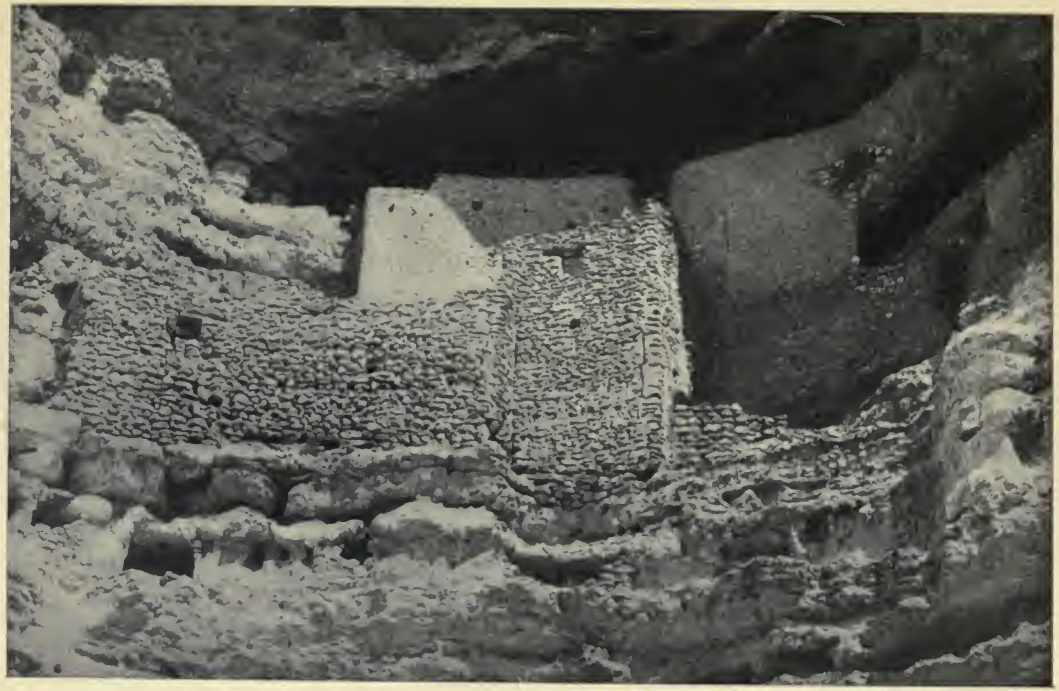


FIG. 75. — MONTEZUMA'S CASTLE, BEAVER CREEK CAÑON, ARIZONA

Near some of the ruined dwellings in this region there are remains of buildings which are supposed to have been watch-towers. We can picture to ourselves the sentinels' alarm given to the workers in the fields at the approach of the savage Apaches, and the hasty flight of the Cliff Dwellers to the castle far up the cañon wall, — the pulling up of the ladders and the retreat to the upper rooms from which they could look down in perfect safety. They must have kept water and food stored in the cave houses. As long as these supplies held out no injury need be feared from the attacking party.

But apparently there came a time when the Cliff Dwellers either abandoned their gardens and fortresses or were killed. It is possible that the climate of the plateau region became more arid and that many of the springs dried up, for there is no water now within long distances of some of the ruins. It is, perhaps, more probable that the attacks of the savages became so frequent that the Cliff Dwellers were driven from their little farms and were no longer able to procure food.

Those who were not killed by enemies or by starvation retreated southward and gathered in a few large villages, or pueblos, where they were still resisting the attacks of their enemies at the time of the coming of the early Spanish explorers.

A careful study of the early inhabitants of America reveals the fact that the Pueblo Indians are the descendants of the race of Cliff Dwellers. Their houses, their pottery, and their religious ceremonies are, so far as can be determined, very similar to those of the Cliff Dwellers. If you travel through northwestern New Mexico and northeastern Arizona, you will find the villages situated

FIG. 76. — PUEBLO OF TAOS, NEW MEXICO

upon commanding rocks which are often surrounded by almost inaccessible cliffs. To these elevated villages all the food and water has to be carried from the valleys below. The houses are solidly built of stone, and rise, terrace-fashion, several stories in height, each succeeding story standing a little back of the one below. These houses can be entered only by a ladder from the outside. In time of danger the ladders are drawn up so that the

FIG. 77.—GRINDING GRAIN, LAGUNA, NEW MEXICO

walls cannot be easily scaled. There are a number of groups of the Pueblo Indians, but the Zuni and Moki are perhaps as interesting as any of them.

Wonderful indeed are some of the pueblo villages which were still occupied at the time of the coming of the Spanish, more than three centuries and a half ago. As in the pueblos now occupied, there were no separate family houses. The people of an entire pueblo lived in one great building of many rooms. Some of the pueblos were semi-circular, with a vertical wall upon the outside,

while upon the inside the successive stories formed a series of huge steps similar to the tiers of seats in an ancient amphitheatre.

FIG. 78. — THE ENCHANTED MESA
The summit was once the site of an Indian pueblo

In the pueblo of Pecos were the largest buildings of this kind ever discovered. One had three hundred and seventeen rooms, and another five hundred and eighty-five. Taos is another of the large pueblos, and is especially interesting because it is still inhabited. This great building has from three to six stories with several hundred rooms. In the foreground of the photograph (Fig. 76) appears one of the ovens in which the baking is done. In some of these pueblos the women still grind their corn by hand in

stone *matates*, just as their ancestors did for many hundreds and perhaps thousands of years.

In northwestern New Mexico there is a remarkable flat-topped rock known as the Enchanted Mesa, which rises with precipitous walls to a height of four hundred feet above the valley in which it stands. It was long believed that human beings had never been upon this rock, although there were traditions to the effect that a village once existed upon its summit. According to the tradition, the breaking away of a great mass of rock left the summit inaccessible ever afterward. The cliffs were scaled recently by the aid of ropes, and evidences were found, in the shape of pottery fragments, to show that the Indians had once inhabited the mesa. Two or three miles away, across the valley, is the large village of Acoma, where a great deal of pottery is made for sale.

FIG. 79. — POTTERY OF THE ACOMA INDIANS, NEW MEXICO

The pottery of the Pueblo Indians is very attractive, and their religious festivals and peculiar dances draw many visitors. These Indians no longer fear attacks from the savage Apache or Navajo, but they have become so used to their rock fortresses that it is not likely they will soon leave them. The Navajos now live in peace and raise large herds of sheep and goats; while the more savage

Apaches have been gathered upon reservations, never more to go upon the war-path. Most of the Apaches still live in their rude brush habitations.

While the Pueblo Indians make attractive pottery, the Navajos are noted for their blankets. The wool, which is taken from their herds, is dyed different colors, and

FIG. 80. — NAVAJO WOMAN WEAVING A BLANKET

woven upon their simple looms into the most beautiful and costly blankets.

We usually think of the native inhabitants of America as leading a wild and rude life, moving from place to place in search of food, and constantly engaged in warfare with one another. The Pueblo Indians alone are different. Possibly if the white man had never come to America these

Indians might in time have become highly civilized. But it is more than likely that in their struggle with Nature in this wild and rugged country, where they were constantly subjected to attacks from their more savage neighbors, they would have sunk lower instead of rising, and would finally have disappeared.

The Apaches were dreaded alike by the agricultural Indians and the early Spanish. Issuing from their mountain fastnesses the Apaches would raid the unprotected villages and missions, and then retreat as quickly as they came. For many years after the American occupation prospectors had to be constantly on their guard, and many are the tragedies that have marked this remote corner of our country.

THE LIFE OF THE DESERT

During the blinding glare of summer the deserts of southwestern Arizona and the adjoining portions of California are forbidding in the extreme. Day after day the pitiless sun pours its heat upon the vast stretches of barren mountain and plain, until the rocks are baked brown and it seems as if every particle of life must have left the seared and motionless plants.

Month after month passes without rain. Now and then light clouds float into sight, and occasionally rain can be seen falling from them, but they are so high that the drops all disappear in the dry and thirsty air long before they can reach the ground. Cloud-bursts may take place about the peaks of some of the higher mountains, but they have very little effect upon the life out on the plains.

Animals and plants brought to this region from a moister climate must drink continually to make up for the rapid evaporation of moisture from their bodies; a day without water may result in death. And yet the living things that have homes in the desert can resist the dry air for many months without a renewal of their moisture. There are areas where the average rainfall is less than three inches, and sometimes two years may pass without a drop of rain. It will certainly be worth our while to find out something about these desert plants and the way in which Nature enables them to get along with so little water.

Go where we will, from the moist heat of the tropics or the dry heat of the deserts to the icy north, we find that everywhere the plants and animals are suited to the climate of the particular place in which they live. Therefore we might conclude that they thrive better in those places than they would anywhere else, but that is not always true.

A struggle is going on continually among plants for a footing in the soil and for a share of the sunshine. The weaker plants are generally killed, while those hardy enough to survive have to adapt themselves to new conditions of life, becoming stunted and deformed upon barren slopes; but they have plenty of room there because fewer plants are striving for the same place.

It is not likely that the deserts of the southwest have always been as dry as they are now. As the amount of rainfall slowly lessened through thousands of years, the animals could migrate when it became too dry; but the plants, fixed in one place, had either to give up and die, or change their characters and habits to suit the demands of the changing climate. The fact that these extremely dry deserts are filled with plant life to-day is without doubt due to this ability to change.

In a moist, warm climate plants are luxuriant; they take up a large amount of water through their roots and evaporate it through the leaves. If placed in a desert, such plants would immediately wither and die. To avoid too rapid evaporation the bodies of the desert plants have become smaller, and their leaves have either shrunk greatly or wholly disappeared. Strong-smelling, resinous juices exude from the remaining leaves and stems, and form a surface varnish through which water passes with difficulty.

Some forms of plant life, such as the prickly-pear, are

provided with fleshy stems which hold a supply of moisture to be drawn upon during the long dry season. Men and animals are sometimes saved from death by chewing the pulp of the prickly-pear or other cactuses. After a period of exceptional drought, the stems of the prickly-pear lose their bright green color and become shrunken.

FIG. 81. — PRICKLY-PEAR, BALL CACTUS, AND SPANISH BAYONET

The development of the underground part of the plant is frequently out of all proportion to the part above the surface. The manzanita, which grows in the semi-arid climate of southern California, is a low shrub with branches that are rarely large enough for fuel. The roots, however, are large and massive, and are extensively used for firewood.

The desert plants are armed, not only against the dry air, but against the wandering animals which would bite them and suck their juices. The smell of the sage-brush is such that very few animals will touch it. Other

plants are protected by thorns. In fact, the drier the region, the more thorny are its plants. A little shrub called the crucifixion thorn has no leaves at all, nothing but long, sharp spines. Besides the straight thorns there are curved and also barbed ones, for every conceivable form is represented among the plants of these dry lands.

FIG. 82. — CRUCIFIXION THORN

As the desert plants are armed against the animals, so the animals are armed against each other. Many of the insects and reptiles are extremely poisonous; the greater the heat of their habitat, the more dangerous are their bites. The horned toad, while not poisonous, is protected by having horny spines upon its head and back. The little rattlesnake known as the "side-winder" is perhaps the most dangerous of all, although the tarantula, centipede, and scorpion are formidable foes. The Gila monster, long believed to be so dangerous, is now considered non-poisonous under ordinary conditions.

The desert tortoise is perhaps the most remarkable of all the animals of the desert. It is rare, and little is known of its habits except that it lives in the most arid valleys of southeastern California, far removed from any

water. This tortoise has a diameter across its shell of at least eighteen inches. Its flesh is much prized by the Indians and prospectors. A specimen which had been without water for an indefinite period was dissected, and the discovery was made that upon each side there was a membranous sac, containing clear water, perhaps a pint

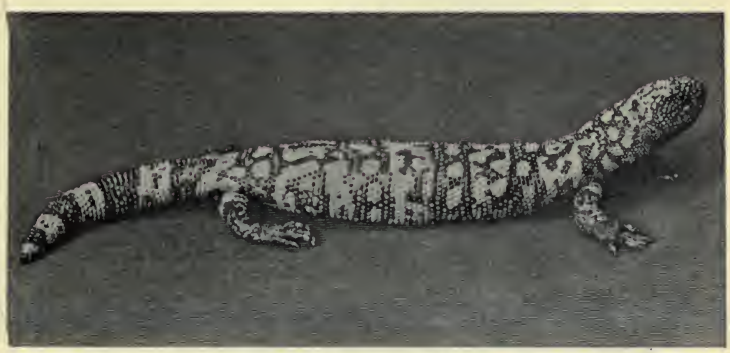


FIG. 83.—THE GILA MONSTER

in all. The desert tortoise, then, carries his store of water with him, and is thus enabled to go many months without a new supply.

A trip across the deserts of the lower Colorado in spring, before the bracing air of winter has entirely gone, is one never to be forgotten. The poisonous insects and reptiles are not at this time warmed up to full activity, while many peculiar plants are just coming into bloom.

Let us study some of the strange forms growing thickly over the rocky slopes and sandy plains. There are miles of forest, but not such a forest as we are accustomed to see. Tall, fluted columns of the giant cactus (saguaro), with rows of sharp spines, reach upward to a height of from

twenty to fifty feet. At one or more nodes, bud-like branches spring from the main trunk and, curving upward, form columns about the parent stem.

The giant cactus bears near the top a purple flower and a large, edible fruit. This fruit, which has a red pulp, is a favorite food with the Indians, and also with many insects and birds. It is gathered by means of long forked

FIG. 84. — THE PALO VERDE TREE AND SAGUARO

sticks, for if it should drop to the ground it would be broken. The pulp of the stalk yields a little juice or sap which is used by the Indians when hard pressed for water.

Scattered among the huge club-shaped columns of the saguaro is the cholla, the next largest of the cactuses. This species, which is tree-like in its branching and in rare cases grows to a height of twelve feet, bears bright red

FIG. 85. — A FOREST ON THE PLAINS OF SOUTHERN ARIZONA
Showing cholla and saguaro

or yellow flowers. One must approach with care, for its jointed stems are so easily broken that at the slightest touch of the hand or clothing, pieces break off and adhere firmly by means of their sharp curved and barbed spines. Another species of the cholla is small, reaching but a foot or two above the ground, but this and other low forms so cover the ground in places that one has to be constantly on guard to keep from running the spines into his feet.

These are not all the plants of this wonderful forest. The ocatilla is a cactus-like form having a group of long slender stems bunched together at the root. In the spring each is tipped with a spike of red flowers, and as the snake-like stalks wave in the breeze they present an appearance scarcely less attractive than the saguaro.

FIG. 86. — OCATILLA

Scattered among the vegetation just mentioned is the palo verde (green tree), so named from the yellowish green of its bark. It is remarkable for the small size of the leaves, which afford scarcely any shade for the traveller upon a hot summer day. (Fig. 84.)

Along the dry water courses we find the mesquite, a tree which does not grow upon the gravelly plains and rocky slopes, for it needs more moisture than most of the desert vegetation. In the spring it puts out delicate green leaves which form a pleasing contrast with the other plants.

Riding through one of these forests in the deepening twilight, one is impressed with a feeling of awe and mys-

tery by the strange, weird shapes outlined against the sky. In the cooler air of evening the animals come from their retreats. The insects and the snakes are then abroad, and if one is on foot the sudden buzz of a rattlesnake is not a pleasant sound to hear.

FIG. 87. — MESQUITE TREE, SANTA CRUZ VALLEY, SOUTHERN ARIZONA

The prickly-pear prefers slopes not quite so dry and hot as those of the forest just described. Its broad, spade-like, jointed stems are very interesting. The red fruit clustered upon their extremities is not disagreeable to the taste, but is covered with a soft, prickly down.

Associated with the prickly-pear is a species of agave, but this does not grow so large in Arizona as it does farther south in Mexico. The plant is familiar to us as the common century plant of our gardens. The long fleshy leaves with spines at the ends are clustered at the surface of the ground, and from their centre, at blooming

time, rises a tall flower stalk. The agave requires many years to mature. When the flower stalk has once started it grows rapidly, but after blossoming the plant dies.

The mezcal, or pulque, the national drink of the Mexicans, is made from the sap of the agave. The fibre of the agave, known as sisal hemp, is used in the manufacture of rope, twine, mats, brushes, etc. Other parts of the plant have various uses.

FIG. 88. — THE AGAVE

FIG. 89. — SPANISH BAYONET IN BLOOM

There are many kinds of yucca in the more elevated portions of the desert. They range in size from those only two or three feet high, of which the Spanish bayonet is a type, to the giant yucca of the Mohave Desert, which attains the proportions of a tree and forms thick forests over an area of many miles. The Spanish bayonet, with its long stalk of white, waxy blossoms, presents a very beautiful appearance, as do also the young specimens of the tree yucca.

At rare intervals, once perhaps in many years, there is an unusual amount of rainfall in the spring, and in a few weeks the desert becomes transformed as if by magic. Seeds germinate, the presence of which one would never have suspected in the drier weather. In an incredibly short time the long gravelly or sandy slopes about the bases of the mountains are covered with a veritable carpet of green, yellow, and red. The sand verbena, the evening primrose, baby blue-eyes, and different kinds of lilies grow so thickly in places that every footstep crushes them.

FIG. 90. — YOUNG YUCCAS IN BLOOM

But in a few short days the beauty has disappeared. The seeds mature speedily and drop into the sand. A hot wind withers the stems and leaves and blows them away; drifting sands take the place of the rich carpet. How readily these plants have adapted themselves to the brief period in which life is possible!

Thus it is that this vast region about the lower Colorado, although so dry and hot, and at first sight apparently so unfitted for sustaining life, nevertheless supports its share. Many of the plant forms have assumed strange and monstrous shapes in their efforts to withstand the hard conditions in the struggle for existence, while others simply lie in waiting, sleeping during the long dry year, but ready to spring into life when the favorable showers come, as they sometimes do.

THE PONY EXPRESS

ALTHOUGH it is only a little more than fifty years since the discovery of gold was made and the rapid settlement of the West began, what a change has come over this great region! It was at first supposed to be impossible to connect the growing settlements upon the Pacific with the East by anything more than a wagon road, and those who advocated the building of a railroad were ridiculed. Now the journey across the continent is made upon smooth steel tracks in comfortable coaches, for the skill of the engineer has overcome the difficulties of the desert, the mountain wall, and the cañon.

The pioneers who pushed westward from the Mississippi River with their slow ox-teams took all summer to reach the fertile valleys of California and Oregon, and considered themselves fortunate if they arrived at their destination before the coming of the winter storms.

The first overland stage line was established by way of New Mexico and Arizona, terminating at Los Angeles. Twenty-two days were required for this part of the tiresome and dangerous trip. The route was longer and more desert-like than that farther north across Nevada, but the winter storms were avoided.

The stage-coach proved too slow for the needs of the growing settlements upon the Pacific slope. A telegraph line was planned, but it could not be completed for some time, and even then it was probable that the Indians would destroy the poles and wires.

Then came the idea of a relay of fast messengers upon horseback, and the pony express was organized. It is difficult to believe that by this means the journey of two thousand miles between St. Joseph, a point upon the Missouri a little above Kansas City, and Sacramento, California, was once made in about eight days. This is only a little more than twice the time required by the fast trains at present.

For two years the trip was regularly made in about nine days, averaging two hundred and twenty miles a day. It can be readily understood that this wonderful feat required many relays of men and horses scattered along the route. The express rider had no well-graded roads to follow, but only the rough trail of the emigrants. This led across broad deserts and over rugged mountains, and throughout most of the journey exposed the rider to the attacks of Indians.

Let us take a map and trace the route of the express. It followed closely the main overland trail which the gold-seekers had opened. Now towns and cities are scattered along the old trail, and the railroad crosses and recrosses it. But let us try to picture the country as it appeared in its wild state.

Mountains, valleys and plains made up the landscape. Vast herds of buffalo darkened the Great Plains east of the Rocky Mountains, while farther west were numerous bands of antelope. The streams were filled with beaver and other fur-bearing animals. Here and there along the rivers were Indian villages with their curiously shaped tepees. Even the deserts of Nevada were not uninhabited, for the Indians lived there also, gathered in little family groups about the desolate springs.

When we speak of the overland trail we do not mean a narrow path for animals, but the wagon road, rude though it was, which the early emigrants had made. They were determined to cross the continent, no matter what the difficulties and dangers. Wagons could be drawn by the oxen over the plains and deserts with little difficulty, although there were some dangerous rivers to be crossed. Mountains and cañons offered the most serious obstructions. In many places the wagons had to be let down over precipices with ropes, or be taken apart and carried piece by piece around the obstructions.

It was not the mountains alone which made the trip "across the plains" one long to be remembered. It was often difficult to obtain water and fodder for the animals, and at many points savage Indians, bent upon plunder, were in hiding, waiting for a chance to stampede the cattle or kill the emigrants. The way was marked by abandoned wagons, household goods, bones of cattle, and the graves of human beings.

The trail led from the Missouri across the state of Kansas to the Platte River, then followed this long stream to its head at South Pass on the continental divide. From the South Pass the trail led southwest past Fort Bridger, in southwestern Wyoming, through Echo Cañon and over Emigrant pass of the Wasatch Range down to Salt Lake City, which had been founded but a short time before the discovery of gold. West of Salt Lake City the trail skirted the northern shore of the Great Salt Lake, and after passing a low mountain divide in what is now northwestern Utah, reached the head waters of the Humboldt River. Thence the path ran along by this river down to the place where it disappeared in a vast sandy

desert known as the sink of the Carson. The Carson River, after the dreary desert was passed, led the emigrants still westward toward a wall of mighty mountains known as the Sierra Nevada. Here Nature seemed to have done her utmost to shut off California, with its fertile valleys and rich gold-fields, from the longing eyes of the emigrants.

FIG. 91. — CHIMNEY ROCK
On the old overland trail near the Platte River, western Nebraska

There are, however, several low places in the range, and through one of these openings, at the head of the Carson River, the travellers gained the western slope of the mountains. Then in good time they reached the mining town of Placerville, and at length Sacramento, the capital of California.

In order that the pony express might make the time required over the two thousand miles, five hundred horses

and several hundred men were needed. The stations were placed about ten miles apart and were strongly built so that they might withstand the attacks of the Indians. These stations, nearly two hundred in number, all had to be supplied by means of freight teams, which often hauled hay, grain, and food for the messengers for hundreds of miles.

The horses selected for the messengers to ride were the small, sure-footed ponies called mustangs. Through a stretch of ten miles the pony was pushed to its utmost speed, then it was carefully groomed, fed, and rested until the time came to make the return trip.

In selecting the riders three things were of great importance: they must be light in weight, must be possessed of great powers of endurance, and also must be brave and resolute. At each station, as the time approached for the express to arrive, the relay horse was saddled and in waiting. As the rider dashed in he jumped from his horse, and with but a moment's rest, threw the saddle-bags containing the letters upon the fresh horse and was off again, riding like the wind. Upon smooth stretches the horses often made twenty miles an hour, but it was quite impossible to maintain this speed over the rocky and rugged portions of the route. Storms and Indian ambuscades often delayed the riders. Sometimes the messenger kept up a running fight with the Indians for miles.

The riders were frequently killed, but the mail-bags were rarely lost. If a rider did not come in on time, it was known that something serious had happened, and search was immediately made. The riders were not allowed to stop for any purpose whatsoever; neither storms of the greatest severity nor even the presence of hostile

Indians near the trail kept them from their duty. One of the few riders who are still living says that he was never afraid except on dark, cloudy nights. At such times he made no attempt to guide his horse, but trusting to the intelligence of the well-trained animal, gave it rein, and at the same time spurred it to its utmost speed. Think

FIG. 92. — PALISADES OF THE HUMBOLDT RIVER, NEVADA
Near the overland trail

of riding at such speed into the dark night, not knowing what is ahead of you! The rider's only safety lay in the carefulness and sagacity of the horse. Such a ride called for more courage than did a conflict with Indians!

The pony express carried no passengers. It carried no freight, not even the usual express package. The

messenger was intrusted with nothing but two bundles of letters carefully stowed away in a pair of saddle-bags.

The letters were not like our ordinary letters, for the paper used was the thinnest and lightest possible. Hundreds of the letters weighed only a few pounds. It was very important that there should be no great weight, for if the horses were heavily loaded, they could not make the required time. Only those whose business was of great importance could afford to send letters by this express, for the charge was five dollars upon each letter.

In spite of the high charge the pony express is said never to have been profitable, for the expenses were very heavy. It was discontinued in 1860, as by that time a telegraph line had been constructed across the continent.

HOW CLIMATE AND PHYSICAL FEATURES INFLUENCED THE SETTLEMENT OF THE WEST

THE story of the exploration and settlement of the Pacific coast, and of the great region lying between the Pacific slope and the Mississippi Valley, offers a most interesting opportunity to study the control which physical features of the earth exert upon the trend of men's activities. The position of the mountains, the courses of the rivers, and the character of the sea-coast have all helped to shape the history of the West. The presence of gold in the rocks of the Sierra Nevada mountains was the chief incentive which led to the breaking down of the barriers placed by Nature between the Pacific and the Mississippi basin.

When an unknown land is accessible by water, the shore line offers the easiest means for the first explorations and settlements. So it came about that nearly all the eastern coast of North America was known before men ventured far into the interior. Then the large rivers, like the St. Lawrence, the Hudson, and the Mississippi, seemed to offer inviting routes into the recesses of the continent, but exploration through the pathless woods and rough mountains was slow.

It was soon discovered that the Hudson was a short river and did not lead across the continent as was at first hoped. Because of the absence of other large

rivers upon that portion of the coast which the English occupied, their settlements did not spread westward as rapidly as they otherwise would have done. The country was covered with dense forests, and savage Indians disputed the right to occupy it. In time, however, passes were found leading over the Appalachian Mountains to the Ohio River and through the Mohawk Valley to the region of the Great Lakes.

The advantages for travel offered by the St. Lawrence River and the chain of lakes above it were utilized at an early day. The route of the French missionary explorers and fur traders was from Montreal up the Ottawa River, then by a short portage and a series of small lakes to Lake Huron. From this point the most remote shores of Lakes Superior and Michigan could be easily reached. By the aid of several small bodies of water west of Lake Superior, Lake Winnipeg and Great Slave Lake were finally discovered; but from this point the waterways into the West were small and could be followed no farther, so that it was a long time before the Rocky Mountains were crossed.

By floating down the Illinois River the French arrived at the Mississippi, explored much of its course, and took possession of the country in advance of the English. This fact was directly due to the difficulties which the English explorers experienced in forcing their way over the Appalachian highlands.

The Spanish explored the southern shores of the continent, and crossing the Isthmus, were the first to behold the Pacific. The fact that the Pacific coast of North America was so easily reached at this point gave the Spanish a great advantage, and explains why they gained such a hold upon the lands bordering that ocean. It was a compara-

tively simple matter for them to fit out ships, and sailing north and south, to take possession wherever they desired. However, when they had gone as far as California, their progress was for a long time almost completely blocked by storms and head winds, for the prevailing direction of the wind is down the coast. The Spanish finally reached Vancouver Island, but never succeeded in making settlements north of San Francisco. Even the interior of California was little known to them, for the mountains and deserts discouraged their progress in that direction.

From an examination of a map we might suppose that the Colorado River would offer as good a means for penetrating the continent as did the Mississippi River, but as a matter of fact it is navigable for a comparatively short distance. The Spanish made one attempt to ascend this river, but finding themselves surrounded on every hand by a most desolate, barren country, they turned back before reaching the Grand Cañon. In the eager search for gold the Spaniards pushed north from Mexico and planted settlements in Arizona and New Mexico, but upon the northwest their progress was stopped by cañons and deserts.

Now we are prepared to understand why it was that the western portion of North America remained for so long a time a mysterious and unknown region. There were no waterways by which it could be explored, while snow-clad mountains and deserts made access to it doubly difficult.

By the beginning of the last century the Americans had overcome the natural obstacles in their westward progress, and their settlements reached as far into the wilderness as the Mississippi River. Hunters and traders were soon pushing far beyond, spreading over the Great Plains and up to the very base of the Rocky, or Stony Mountains, as

they were then called. The Missouri River became the great highway into the Northwest, for the adventurers took advantage of the streams wherever possible. Many other rivers were discovered flowing from the western mountains, but with the exception of the Platte and Arkansas they were generally too shallow for navigation even with a light canoe.

Starting in the early spring from the mouth of the Missouri, the hardy trappers sailed and paddled up the river, taking several months to reach the head of navigation at the Great Falls. In the autumn, when the boats were loaded with furs, it was a comparatively easy matter to drop down the river with the current. It would have been almost impossible to transport the loads of goods on pack-horses across the thousand miles of prairie, where the traders would be subject to attack from hostile Indians.

Adventurous men pushed farther and farther west through the passes in the mountains and began trapping upon the waters which flow into the Pacific. It had long been supposed that the Rocky Mountains formed a barrier beyond which our country could not be extended, and that the Pacific slope was made up of mountains and deserts not worth securing.

The explorers showed that the Rocky Mountains were not continuous, but consisted of partly detached ranges, and that while their eastern fronts were indeed almost impassable for long distances, there were places so low that it was difficult to locate the exact spot where the waters parted to seek the Pacific Ocean and the Gulf of Mexico. In southwestern Wyoming the continental divide, known as the Great Divide mesa, though more than a mile above the sea, is but a continuation of the long, gentle slope of the Great Plains.

The Rocky Mountains decrease in height toward the south, near the line between New Mexico and Colorado. Here is situated Raton Pass, an ancient Indian highway from the valley of the Arkansas to the Rio Grande. In the early half of the last century this trail was much

FIG. 93. — ON THE CONTINENTAL DIVIDE IN SOUTHWESTERN WYOMING

used by the caravans of traders and came to be known as the Santa Fé trail.

In the early days of the American occupation of California, the Santa Fé trail became an important route to the Pacific. From the Mexican town of Santa Fé it led down the valley of the Rio Grande, following the old road to Mexico, and then turned west across the broad plateau of the continental divide, not far from the present course of the Southern Pacific Railroad. Passing Tucson, the road kept near the course of the Gila River to Fort Yuma,

and then led over the Colorado Desert to Los Angeles. This path avoided all the high mountains, but much of it lay across deserts, where the heat and scarcity of water made it an impracticable route for the emigrants.

One not acquainted with the physical geography of the West might wonder why the gold-seekers on their way to California did not make use of the Missouri River, which, except for the Great Falls, was navigable for small boats to the very base of the Rocky Mountains. A partial explanation is found in the report of the hardships endured by the Lewis and Clark exploring expedition, and later by the Astor party, which went out to found a fur trading post at the mouth of the Columbia. It had been supposed that after once crossing the continental divide it would be an easy matter to embark upon some stream and float down to the Pacific Ocean. The parties referred to became lost in the defiles of the mountains, and when they finally reached the Snake River it was only to find that rapids and waterfalls continually obstructed navigation. Although there was in most places plenty of water upon this northern route, yet the mountains were impassable for wagons.

Because of these conditions the emigrants started out boldly across the plains, following the general course of the Platte River, and crossing the Rocky Mountain divide at the South Pass in western Wyoming, a place famous in its day. At this point those who were going to Oregon turned northwestward to Fort Hall, a trading post of the Hudson Bay Company. From here they crossed southern Idaho, keeping near the course of the Snake River until they reached the point where it enters the grand cañon; there they left the river, and climbing over the Blue Mountains, entered the fertile valleys about the present

city of Walla Walla. From this place the emigrants followed the Columbia River to The Dalles, whence they proceeded either by boat or raft until Fort Vancouver and the mouth of the Willamette were finally gained. Wagons were taken through on this route, and it was not dangerous,

FIG. 94. — THE OLD SANTA FÉ TRAIL
Over this thousands of freight and emigrant wagons have passed

although accidents sometimes happened at the Cascades, where locks were built at a later day.

The emigrants for California, who were the most numerous, turned southwest at South Pass, and after crossing the Wasatch Range through Emigration Cañon, came out upon the plain of Great Salt Lake. Then, traversing desert plains, they reached the Humboldt River, which they followed until it sank into the sands.

Several routes had been opened across the Sierra Nevada mountains into California, but those through the Carson and Donner passes were most used. Several high ranges of mountains lay between the Willamette Valley of Oregon and the Great Valley of California, so that in the early days there was very little travel between these two territories. The overland trip required so long a time, and involved such dangers and hardships, that many preferred the water route, in spite of the fact that its ships were crowded, and the voyagers must cross the fever-infected Isthmus.

It is very interesting to note how widely different the rivers are upon the opposite sides of the Rocky Mountains. Those upon the east, with the exception of the Missouri at the Great Falls, are not marked by waterfalls after leaving the mountains. There are few cañons of importance. The streams generally flow in channels only slightly sunken below the general level of the Great Plains. The streams upon the west, on the contrary, are broken by rapids and waterfalls, and are generally buried in cañons so deep and precipitous that in places a man might die of thirst in sight of water.

No other great migration of people over the surface of the earth ever encountered such difficulties as that which pressed westward after the discovery of gold. It was at first thought that railroads could not be constructed through the mountains and deserts, and until the mineral wealth of the West became known, many men believed that the greater portion of the country was not worth taking.

It would be interesting to consider each of the main lines of railroad which connect the Mississippi Valley with the Pacific, and study the features of the country

through which it runs, determining as far as possible the surveyor's reasons for selecting that particular course. Some of the railroads follow for long distances the routes of the emigrants. The emigrants, in their turn, often made use of the ancient Indian trails.

FIG. 95.—THE CARSON PASS, SUMMIT OF SIERRA NEVADA MOUNTAINS
One of the main emigrant routes to the Pacific Coast

While Nature seems to have striven to raise impassable barriers to shut off the Pacific slope from the rest of the continent, yet she failed at some points, and through the unguarded passes the wild animals and Indians first found their way. Then came the trappers, prospectors, farmers, and at last the railroad, until the wilderness was over-run.

Because of its temperate climate, abundant rainfall, and rich soil, the Mississippi Valley was rapidly settled after the pioneers had once reached it. The plains rising slowly westward toward the base of the Rocky Mountains were found to be more arid the farther they were explored. Consequently there exists a broad strip of plain which is even to-day sparsely settled. The emigrants went on to the fertile valleys nearer the Pacific, where the rainfall is more abundant. The American settlers did not then understand irrigation, although it was practised by the Mexicans to the south. Because the discovery of precious metals was first made in California, the pioneers crossed the intervening mountains without giving a thought to the mineral riches which might be concealed in their depths. Later, mines were opened in the mountains all through the arid regions. The necessity of providing food for the miners brought about the discovery that the desert lands were very productive wherever the waters of the streams could be brought to them.

THE LIFE OF THE PROSPECTOR

PERHAPS some of us who have comfortable homes, sleep upon soft beds, wear neat clothes, and can obtain every variety of food that we wish, think with pity of the men who lead a rough and lonely life among the mountains far from all comforts. Let us learn something more about the life and work of the prospectors, for we may find much that is desirable in their experiences.

Not many thousands of years ago our ancestors led what we would now call a wild and savage life. They had no permanent homes, but wandered here and there in search of food, and lived in caves or constructed the rudest kind of shelter from the storms. Perhaps we are right in feeling thankful that we were not born in those primitive times, but are there not really many things to regret about the way in which we have to live at the present day?

The utterly free outdoor life is not open to many. We have little or no opportunity to become acquainted with Nature, the guardian of our ancestors. The woods, the rocks, the mountains, and the dashing streams are almost complete strangers to many of us.

Many men are now obliged to go every day to their work in office or shop, and spend the hours shut in from the fresh air and bright sunshine. At night they sleep in rooms into which they admit little fresh air for fear of taking cold. To-day each man has to learn to do one thing well to the exclusion of nearly everything else, in

order to make a living. For this very reason we are in danger of becoming human machines and of losing the use of some of the powers with which Nature has endowed us. Many things about our present mode of life are not natural to us, but through successive generations we have become somewhat adapted to them. The Indians, if taken from a life in the open air and made to live as we do, often sicken and die.

The farmer enjoys much more freedom and more of the sweet fresh air than do the artisans and office workers; but of all the men in civilized countries the trappers and prospectors live most out of doors. To be sure, they have to endure many hardships and dangers, and their beds are not always the softest nor their food the best, but you will seldom find one who is willing to exchange his free life for work in the town or city.

The trappers have nearly disappeared. Their occupation will be gone with the passing of the wild animals which were once so abundant. The prospectors are, however, becoming more numerous year by year throughout the mountains of western America. To them we owe a great debt, for had not their searching eyes brought to light the hidden mineral deposits this portion of our country would be far more thinly populated than it is to-day.

The discovery of gold in California was accidental. A man named Marshall was building a mill for Sutter in the foot-hills of the Sierra Nevada mountains at the time (1848) when California had just come into the possession of the United States. While at work he noticed some shining grains in the sand of the mill-race. A little testing of the grains led him to the conclusion that they were gold.

The news spread rapidly over the world, and since

that time a constantly increasing tide of gold-seekers has been pushing out into the unexplored portions of the earth. Comparatively few of these men have become wealthy, but their discoveries have led to the settlement of new regions and to the growth of important industries. In truth, if it were not for the deposits of valuable metals, large areas of the desert and mountainous West would be of small value.

The prospector needs little capital except health and strength, but he must be willing to lead a rough life. He will be more likely to succeed if he knows something about the different kinds of minerals and rocks, and is able to distinguish the valuable ones from those which are of little or no worth.

FIG. 96.—A PROSPECTOR IN THE DESERT

The prospector may have a pack-horse and a second horse to ride, or he may go afoot with merely two burros to carry blankets, provisions, and tools. A burro costs little and will live upon almost anything. The variety of food that can be carried is not large; such things as bacon, flour, sugar, beans, and coffee are the most important. With the rifle one may frequently add to the supply. This, you may think, is pretty hard fare, but life in the

open air will make one hungry enough to relish almost any sort of food.

The prospector does not need a road or even a trail. He seeks the least-known portion of some mountain district where he has an idea that gold may be found. Through the cañons he goes, and over the mountains, either on horseback or driving the burros before him. Water and grass are usually abundant, and the little cavalcade stops where night overtakes it. In the desert prospecting is more difficult and often dangerous, because of the scarcity of water. It is necessary to know the location of the few scattered springs, and to make one of the burros useful in carrying water kegs. A spring must be the starting-point in the morning, and a sufficient amount of water must be taken to last until the traveller can get back to the same spring or until he can reach another.

A pick, a shovel, and a hammer are among the most important parts of the prospector's outfit. Gold is a heavy substance, and as it washes down the mountain sides and into the gulches from some quartz vein, its weight finally takes it to the bed-rock beneath the sand and gravel. With his pick and shovel the prospector can reach the bed-rock. He takes some of the gravel from its hiding-place close to the rock, places it in a pan filled with water, and then, with a peculiar rotary movement, washes away the lighter materials, leaving the heavier substances and the gold, if there is any, at the bottom of the pan. If there is no trace of gold, the prospector goes on to another creek; but if some of the yellow metal is washed out, he tests the place thoroughly for more.

In searching for ledges the prospector spends his time in the smaller gulches and upon the mountain sides.

Every piece of detached quartz that meets his eye is examined, and if any specks of gold appear, the search is directed toward the vein or ledge from which the specimen came. With the hammer, pieces of quartz are broken from the veins which here and there rise above the surface

FIG. 97.— A PROSPECTOR'S CABIN IN THE ROCKY MOUNTAINS

of loose and crumbling rock. When the worker finds a piece that is stained with iron and has the appearance of carrying gold, he places it in his bag and keeps it for further examination. At camp, the pieces of quartz are pounded to a powder in a mortar and then washed in a horn spoon. A string of fine grains of gold tells of the discovery of a rich vein.

It is not usually an easy matter to find the home of a piece of stray quartz upon the mountain side. Days and

weeks may pass while search is made up the slope, for the fragment must have come from some point above. But the ledge, once discovered, is traced along the surface for the purpose of determining its direction and extent.

When a promising bed of gravel or a vein of gold-bearing quartz is found, the prospector posts the proper notices of his right to the claim and has them recorded at the nearest land office. Then he makes a permanent camp by cutting down trees and building a cabin. The interior of the cabin is very simple. Its table and chairs are made of split lumber. One end of the single room is occupied by the bunk, and the other by a large fireplace. There may be no windows, and the roof may be made of earth piled upon logs, or of long split shingles commonly known as shakes.

Sometimes, after discovering a very rich quartz ledge, the prospector goes back to a settlement to attempt to interest some one in buying or developing it. Sometimes it happens that he loses the location of the vein and cannot go back to the place where it was discovered. In this way his discovery becomes a "lost mine," and grows in importance in people's minds as the story of its riches spreads from one to another. Although men may spend years looking for such mines, they are not often found again.

Frequently two men go prospecting together so that their work will be less dangerous and lonely. If they are not at once successful, they manage in some way to get supplies for a trip each year into the mountains. Often they are "grub-staked," that is, some man who has money furnishes their supplies in return for a share in their findings.

If they have enough to eat, the prospectors, in their snug cabin, are comfortable and happy. The cabin is built as near as possible to the mine, so that the men need not be cut off from their work during the stormy weather. The temperature underground is about the same in both winter and summer, so that winter storms and summer heat form no hindrance to the work.

FIG. 98.— MOUTH OF A TUNNEL

Years spent in life of this kind lead men to love the mountains. They feel a sympathy with Nature and a companionship in her presence. When they have to visit the town for supplies, they long to get back to their little cabins. They feel lost in the whirl and confusion of the city.

Summer is a delightful time at the many little miners' cabins scattered through the mountains. The air is invigorating, the water pure and cold. There is everything in

the surroundings to make one happy. In the winter the miner sits by his great fireplace, with the flames roaring up the chimney. He has no stove to make the air close and oppressive. About the fireplace his dishes are arranged—the kettle for beans, the coffee-pot, and the Dutch oven in which the bread is baked. If there are some old paper-covered story-books at hand, it does not matter how fiercely the storms rage without. Ask any old prospector who has spent years in this manner if he would exchange his cabin for a house in the city, and he will most decidedly answer "no."

This lonely life in the mountains seems to engender hospitality. The old-time prospector will make you welcome to his cabin and will share his last crust with you. When he asks you in to have some coffee and beans, he does not do it merely for the sake of being polite, and he will feel hurt if you do not accept his hospitality. His dishes may not be as white as those to which you are accustomed, but I will venture to say that you have never tasted better beans than those with which he will fill your plate from his soot-begrimed kettle.

We ought all to see more of this wild life. Even if we do not care to make our permanent homes among the mountains, it would do us good to go there every summer at least, and so not only become stronger, but cultivate that familiarity with and love for outdoor life which our ancestors enjoyed.

GOLD AND GOLD-MINING

Gold derives its value partly from its purchasing power, partly from those properties which make it serviceable in the arts, and partly from its beauty. The high esteem in which gold money is held is as much the result of its comparative rarity as of its physical properties. Among nearly all the nations of the world it has been agreed upon as a standard of exchange. Gold has one disadvantage as a medium of exchange; it is rather too soft to wear well. But this difficulty is overcome by alloying the gold with another mineral of nearly the same color, — copper, for instance.

In order that we may understand better the position which gold occupies in the arts and trades of the world, let us compare it with other metals, and first with platinum. This mineral is far less abundant and has many properties which make it valuable in the arts. Like gold, platinum is malleable and ductile and does not tarnish in the air, but it differs from gold in not being easily fusible, so that it is used in the laboratory for crucibles. The steel-gray color of platinum is, however, so much less attractive than the yellow of gold, that it is not used for ornamental purposes.

An effort was made at one time by Russia, where a comparatively large amount of platinum is found, to coin this metal into money, but its continued use was not found practicable because of its changing price in the markets of

the world. If the leading nations would agree upon a fixed value for platinum, it might be used like gold as a medium of exchange.

Silver is brighter and more attractive than platinum, but is of little use in the laboratory. It has been found in recent years to be so much more abundant than gold that its value has decreased greatly as a commercial article. In our country when coined it has, like paper money, been given a value equal to gold.

The diamond has a value far exceeding that of gold, but this value is dependent almost wholly upon its ornamental properties, although the brilliant stone is also useful as an abrasive and cutting agent.

From these facts it is evident that gold, because of its rarity, its physical properties, and its beauty, combines a larger number of desirable characteristics than any other mineral.

Gold can be found in very small quantities nearly everywhere. It is present in all the rocks and also in sea-water. The gold that is distributed in this manner is of no value to us, for it would cost many times as much to obtain it as it is worth. Nature has, however, concentrated it for us in some places. In portions of the world where the crust has been folded and broken there are veins of quartz extending in long, narrow, and irregular sheets through the rocks. This quartz is the home of the gold, and it is usually found in hilly or mountainous regions.

Do not mistake the yellow iron pyrites for gold. Pyrites is brittle, while gold is malleable. You can hammer a little grain of gold into a thin sheet. Do not make the mistake, either, of thinking that the shining yellow scales of mica which you see in the sand in the bottom of a clear

stream are gold. These yellow minerals that look like gold have been called "fools' gold" because people have sometimes been utterly deceived by them.

Upon the Pacific slope minerals are now being deposited in some of the openings of the rocks from which hot

FIG. 99. — A GOLD-SILVER MINE
Summit of San Juan Range, Colorado

springs issue. A study of these springs has led to the opinion that the gold-bearing quartz veins were formed in a similar manner, but at a very remote time in the past.

The milky or glassy quartz, which is so hard that you cannot scratch it with the point of your knife, the little grains of pale yellow iron pyrites, and the grains and

threads of gold scattered through the quartz, were at one time in solution in water. This water came from some region far down in the earth, farther than we can ever reach with the deepest shafts, and there, where it is very hot and the pressure is great, the water dissolved the little particles of gold and other minerals from the rocks; and

FIG. 100. — HYDRAULIC MINING ON THE KLAMATH RIVER, CALIFORNIA

then, gathering them up, bore them along toward the surface, depositing them as solid particles again in the form of veins in the fissures through which the stream was passing.

As the rocks upon the surface decay and the crumbling material is carried away by running water, the gold, being very heavy, washes down the hillsides and is at last gathered in the gulches. This fact explains why we find gold both in veins and in the gravel of the streams.

Getting gold from the veins is called quartz-mining. Washing it from the gravel is called placer-mining; and if the gravel is deep and a powerful stream of water is required, the work is called hydraulic mining.

Every one has heard of the Mother Lode of California. Every miner wishes that his mine were upon this famous lode, which is made up of a large number of quartz veins

FIG. 101. — MAY ROCK, A VEIN OF QUARTZ ON THE MOTHER LODE

extending along the western slope of the Sierra Nevada mountains, and is marked by hundreds of important mines. A line of towns marks the course of the Mother Lode for over a hundred miles. They are almost entirely supported by the gold which the lode supplies.

The gold first discovered in California was placer gold. After the miners had worked over the stream gravels and had secured all that they could in that way, they began to search for the home of the gold. It could not always

have been in the creek beds, and the miners were correct in thinking that it must have been washed from some other place. Gold was so frequently found in pieces of loose or float quartz that this fact finally turned their attention to the quartz veins which were numerous upon the mountain slopes. Then came the discovery of the series of great quartz veins now known as the Mother Lode.

FIG. 102. — AN ARASTRA

When the miners first found the quartz flecked with gold, they used the simplest means for separating the two substances. If the quartz was very rich in gold, it was pounded and ground fine in a hand mortar. Then the lighter quartz was washed away and the gold left.

The miners also made use of the Mexican arastra. This is a very crude apparatus, and is employed even now by miners who cannot afford to procure a stamp-mill. To

build an arastra, a circular depression ten or twelve feet wide and a foot or more deep is made in the ground. This depression is lined with stone, which forms a hard bottom or floor. Four bars extend outward from an upright post placed in the middle of the floor, and a large flat stone is fastened to the end of each bar by means of a rope. A

FIG. 103. — THE STAMPS IN A QUARTZ-MILL

horse is hitched to one of the bars, which is purposely left longer than the others. The ore is thrown into the arastra, and water is admitted, a little at a time. As the horse is driven around the stones are dragged over the circular depression, crushing the ore and setting free the gold.

This way of separating the gold was too slow, and in a short time the stamp-mill was invented. It has grown from a very simple affair into the great mill which crushes

hundreds of tons of ore in a day. The iron stamps each weigh nearly half a ton. They are raised by powerful machinery and allowed to drop in succession upon the ore, which is gradually fed under them. The stamps crush the ore to a fine sand more easily and rapidly than could be done by any other method. Water is kept running over the ore, and as fast as it is crushed sufficiently fine for the particles to pass through a wire screen, the water with which they are mixed is allowed to flow over large plates of copper which have been coated with quicksilver. The latter mineral has an attraction for gold, and so catches and holds most of the particles, no matter how small they are.

The compound of gold and quicksilver is a soft white substance known as amalgam, utterly unlike either metal. When the amalgam is subjected to heat, the quicksilver is driven off in the form of a vapor, and the gold is left pure. The quicksilver vapor is condensed in a cool chamber and is used again.

The iron pyrites in the ore contains gold which cannot be separated by the crushing process and a machine called a concentrator has been invented to save this also. After passing over the copper plates the crushed rock and pyrites are washed upon a broad, flat surface, which is moving in such a way that the lighter rock waste is carried away by the water. The pyrites now appears as a dark, heavy sand. This sand is placed in a roasting furnace, where the sulphur is driven off, and the gold and iron are left together. Now the gold is dissolved by means of chlorine gas, with which it unites in a compound called gold chloride. From this compound the metallic gold is easily separated. All this may seem a complicated process, but it is carried through

so cheaply that the ore which contains only two or three dollars to the ton can be profitably worked.

Not all quartz veins carry gold. There are many in which not a single speck of the precious metal can be found. Gold usually prefers the society of quartz to that

FIG. 104. — MINING THE GRAVEL OF AN OLD RIVER-BED

of other substances, for minerals, like people, seem to have their likes and dislikes. Along the Mother Lode, however, gold is sometimes found in little bunches and "stringers" scattered through slate. In such cases the slate is mined and sent to the mill.

Some miners devote themselves to pocket mining. They trace the little seams in the rock, and where two seams cross they sometimes find what they call a "pocket." This is a mass of nearly pure gold of irregular shape,

varying from a few dollars to thousands of dollars in value. This kind of mining is very uncertain in its results, for a man may make hundreds of dollars in one day, and then not find anything more for months.

The western slope of the Sierra Nevada mountains was once covered with the camps of thousands of placer miners. Piles of boulders and gravel are scattered along the creeks where the eager workers took out millions of dollars' worth of gold-dust and nuggets. Now many of the streams and gulches are entirely deserted. But in other places, where the quartz veins outcrop, there are scores of stamp-mills at work, night and day, pounding out the gold. Some of the mines have been sunk more than a half mile into the earth, and the gold is still as abundant as ever.

In some portions of the mountains hydraulic mining is more common than quartz-mining. Years ago many of the rivers occupied different channels from their present ones. The gravels of these old channels in the Sierra Nevada mountains, and in other parts of the West where gold-bearing veins occur, are rich in gold. In these channels the gold is so deeply buried that it cannot usually be obtained by means of pick and shovel. In order that the overlying gravel may be removed as cheaply as possible, water is supplied by means of ditches, often many miles long. From some near-by hill the stream is conducted down to the mine in strong iron pipes. It thus acquires a great force, and when directed against a gravel bank rapidly washes it away. Torrents of water bearing boulders, gravel, and sand, together with the particles of gold, are turned into sluice boxes lined at the bottom with quicksilver. This metal catches the gold and forms an amalgam as it does in the quartz-mills.

COPPER-MINING

THERE is a city hidden away in a narrow cañon in the extreme southern portion of Arizona which is supported solely by a copper-mine. The cañon lies upon the southern slope of a range of mountains, and from its mouth one can look far off to the south across the desert plains and mountains of Mexico. The city has an elevation of more than a mile above the sea, and the cañon in which it is situated is so narrow and steep-walled that you can almost jump down from one street upon the roofs of the houses along the street below. Stairways, instead of walks, lead up the hillsides from the main street in the bottom of the cañon.

You might well wonder at the position of the city, and think that out of all the waste land in this region a better place might have been selected for its location. But cities grow where people gather, and people do not come to live in the desert unless there is important work to be done there.

A party of prospectors who were searching carefully over the mountains found several mineral veins with green copper stains crossing this cañon and outcropping in the adjacent hills. Claims were staked out and recorded at the nearest land office. Then shafts and tunnels were opened, and the miners became confident from the rich character of the ore that an important copper-mine might be developed.

Supplies were brought across the desert with teams, and cabins were built in the lonely cañon. Then an enterprising man started a store. As the mine was opened farther, its importance was better understood. There was a call for more miners and the town grew larger. The houses clustered about the mine, the centre of all the activities. At last a railroad was built, and the town became a city, with narrow, winding streets occupying the winding cañon, while tier upon tier of houses crept up the sides of the cañon, which formerly had been covered only by growths of cactus and other plants of the desert.

If the mine should close, there would be no inducement to keep people in the locality, and the city would become merely a group of deserted buildings. Water is so scarce that only a small amount is allowed to each family, and it is delivered in barrels instead of by pipes. Provisions of all kinds are very expensive, for they have to be brought a long distance.

The great mine supports the thousands of inhabitants. The varied industries represented there are dependent upon it alone. As long as it pays to mine the copper, the people are as contented as if they were not tucked away in a cañon in a remote corner of the world.

The most interesting things to be seen about the city are the mine and the smelter. In the former the ore is obtained; in the latter the ore goes through various processes until it comes out in the form of shining, metallic copper. The copper ore, we must understand, is not metallic or "native copper," as it is called when found pure, but a combination of copper with other substances which change its appearance entirely.

The mine is opened by a shaft, that is, a square hole sunk

FIG. 105. — COPPER SMELTER AND CITY OF BISBEE, ARIZONA
The pipe leading up the hill carries away sulphur fumes from the smelter

in the ground. The shaft of this mine is a thousand feet deep, and is being continually extended downward. If we wish to go down into the mine, we must put on some old clothes and get the foreman to act as guide. The cage in which we are to descend stands at the mouth of the shaft, suspended by a steel rope. It looks much like the elevators found in city buildings. At different levels horizontal passages, called drifts, extend to the right and left upon the vein of copper ore. We step out of the car at one of these levels and with lighted candles start to walk through a portion of the mine. There are so many miles of tunnels that it would take us days to go through them all.

Overhead, under our feet, and upon the sides of the drift, lies the vein of copper ore, presenting a different appearance at different places. The various ores sparkle in the light and we gather specimens of each. The common ore is chalcopyrite, a copper sulphide; that is, it is composed of copper and sulphur. It has a brass-yellow color, but is often stained with beautiful iridescent tints. In places the chalcopyrite has been changed to the delicate green carbonate of copper called malachite. In other places it has given place to the oxide of copper. The little crimson crystals of this mineral give bright metallic reflections.

The deposit of copper ore is apparently inexhaustible, for in places the vein widens so that chambers one hundred feet wide and several hundred feet long and high have been made in taking it out.

In going through the mine we have to be very careful not to step into openings in the floor of the passages, or drop rock fragments into them, for far below miners may be working. The places where the men are taking out the ore

are called "stopes," and to reach them we have to crawl and creep through all sorts of winding passages, now through a "manhole," and now down a long ladder which descends into black depths.

From the stopes the ore, as it is blasted out, is shovelled into chutes running down to some drift where there are men with cars. Each car holds about a ton of ore, and after being filled it is pushed along the drift and upon a cage which raises it to the surface.

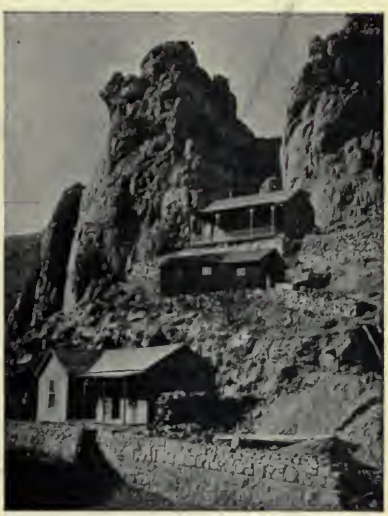


FIG. 106. — HOMES OF MINERS, BISBEE, ARIZONA

The mine is not wet, for there is so little rain in this region that there are few underground streams. In places, however, it is warm, for when the oxygen of the air reaches the fresh sulphide it begins to oxidize the ore; that is, it begins to burn it, and change it into a different compound, just as fire changes wood or coal. Wherever oxidation is going on, heat is produced.

Fresh air is constantly needed in these workings far underground. A supply is forced down in pipes, and then allowed to flow back to the surface. In this way a thorough circulation is kept up.

Underground one loses all thought of the changes

between night and day, for it is always dark there. Consequently we are surprised on coming up from the mine to find that night has settled over the town. Lights are twinkling everywhere, and miners with their pails of luncheon are coming for the night shift.

Another interesting experience now awaits us in the form of a visit to the smelter. Here the bright copper is extracted from the rough-looking ores. How different the two substances appear! They look as if they had scarcely anything in common.

The interior of the smelter seems like a bit of the infernal regions set upon the earth. While watching what goes on, we might imagine that we were far down in the earth, where Vulcan, the fire god, was at work. At night the scene is particularly weird and impressive, for the shadows and general indistinctness make everything appear strange. The glowing furnaces, the showers of sparks, the roar of the blast furnaces, the suffocating fumes of sulphur, and the half-naked figures of the Mexican workmen, passing to and fro with cloths over their mouths, form all together a bewildering scene.

The ore is first pulverized, and then placed in large revolving cylinders, where it is roasted. A fire is started in the cylinder at first, but after the ore becomes so much heated that the sulphur in it begins to burn, no further artificial aid is necessary. Little by little the ore is added in quantities sufficient to keep the fire going. The object of the roasting is to drive off as much sulphur as possible.

After being raked from the roasting furnace, the ore is wheeled in barrows to the huge upright furnaces and is thrown in. Here such materials as limestone and iron are also added to aid in the formation of a perfectly fused

or molten mass. These substances are known as fluxes. With the melting of the ore the copper begins to separate from the impurities.

The melted ore, in the form of a glowing liquid, gathers at the bottom of the furnace and runs out into a large kettle-like receptacle. When one of these vessels is full

FIG. 107.—SHIPPING COPPER MATTE

it is tipped up and the molten copper which has collected at the bottom, because it is heavier than the slag, is allowed to run into another large kettle, supported by chains from a rolling truck above.

The slag is dumped into a car and is carried outside, while the huge dish containing the copper and some slag is swung to the opposite side of the building, where its contents are cast into another furnace. A very strong

blast of air is forced up through the molten mass in this furnace, and the remaining portion of slag is blown out at the top in a shower of glowing particles.

From the bottom of the furnace the liquid copper is drawn out and allowed to run into moulds where it finally cools. It is then known as copper matte. The copper still contains some impurities, and retains in addition whatever gold and silver may have been present in the ore. Most copper ores carry a small amount of these precious metals.

The heavy bars of copper matte are now ready for shipment to some manufacturing point, where they are refined still further and made into the various copper utensils, copper wire, etc. Copper is valuable for many purposes, as it does not rust easily, is highly malleable and ductile, and is a good conductor of electricity.

In the great copper-mines upon Lake Superior, copper is found in the native state mixed with the rock, and does not have to be smelted; but in most mines the ore must go through a process very like the one described before metallic copper can be obtained.

It does not matter how remote a region may be, how intense the heat or cold, or how desert-like the surrounding country, men will go to it if minerals of value are discovered; and there they will perhaps spend the whole of their lives, mining these substances which are of such importance to the industries of the world.

COAL AND PETROLEUM

People are beginning to ask where fuel will be obtained when the coal-beds are exhausted and the petroleum is all pumped out of the earth. The cold winters will not cease to come regularly, and we shall continue to need fires for many purposes. This is a question which need not trouble us. So long as the sun lasts in the sky and the oceans cover so much of the earth, and so long as there are mountains upon the land, there must be streams with rapids and waterfalls. The power of these streams, which has for ages gone to waste, is now being turned into electricity for purposes of light and heat. We may be sure that long before the mines cease to produce coal and the wells to supply petroleum, there will be something better ready to take their places.

But coal and petroleum are still such important commodities that every one should know something about the way in which they were made. This earth of ours has had a very long history, much of which has been recorded in the rocks beneath our feet, and the record is more accurate than are many human histories which have been preserved in the printed books.

The story of the earth has been divided into different periods, each marked by the predominance of certain kinds of living things. The Carboniferous period has been so named because at that time the climate and features of the earth in many places favored the growth

of dense and heavy vegetation. This vegetation accumulated through the long years, so that it formed thick deposits which gradually changed to beds of coal. It would be wrong, however, to think that all the beds of coal were formed at about the same time. Ever since there have been forests and marshes upon the earth there have been opportunities for the forming of coal-beds. Materials are accumulating even now which will in time be transformed to beds of coal.

We must be equally careful to gain correct ideas of the making of petroleum, for many wrong notions are current. While coal has come from the accumulation of plant remains, petroleum has been derived from sea organisms, chiefly animals. If coal and petroleum are found near each other, the occurrence is accidental and does not mean that the two substances are in any way related.

Our earth is very old, and its surface has gone through many transformations; mountains, plains, and portions of the sea floor have changed places with one another. Wherever there have been marshy lowlands, since plants first began to grow luxuriantly upon the earth, it has been possible for beds of coal to be formed. We all know how rankly plants grow where there is plenty of heat and moisture. Many of us have been in swampy forests and have seen the masses of rotting tree trunks, limbs, and leaves. Now, if we should form a picture in our minds of such a swamp slowly sinking until the water of some lake or ocean had flowed over it and killed the plants, and then washed sand and clay upon the buried forest until it was covered deeply in the earth, we should understand how the coal-beds began. Veins of coal that have been opened by the miners frequently show trunks and

stumps of trees, as well as impressions of leaves and ferns. Underneath the coal there is usually a bed of clay, while above sand or sandstone is commonly found.

The oldest coal has been changed the most. It is hard and rather difficult to ignite, but when once on fire it gives more heat and burns longer than other coals. This coal, known as anthracite, is not found extensively in the United States outside of Pennsylvania. Coal which is younger and has been less changed by the heat and pressure brought to bear upon it when it was buried deep in the earth, is known as bituminous. This is the kind of coal which is found in the Mississippi and Ohio valleys, in the Rocky Mountains, and upon the Pacific slope. A still younger coal, which is soft and has a brownish color, is called lignite, and is found mostly in the South and West.

Still another sort of fuel, known as peat, is found in swamps where considerable vegetation is now accumulating, or has accumulated in recent times. Peat is a mass of plant stems, roots, and moss, partly decayed and pressed together. In countries where wood is scarce peat is cut out, dried, and used for fuel.

The larger part of the coal in the eastern United States was formed during the Carboniferous period. That part of our country was then low and swampy; but the West, which is now an elevated area of mountains and plateaus, was at that time largely beneath the ocean.

Then, as the surface of the earth continued to change, the ocean retreated from the Rocky Mountain region, and extensive marshy lowlands with lakes of fresh or brackish water came into existence. There were such marshes in the areas that are now covered by New Mexico, Colorado, Wyoming, Dakota, and Montana. Westward for some

distance the land was higher, but in the states of Washington, Oregon, and California there were other marshy lowlands covered with heavy vegetation.

We know from what we have seen of the manner in which wood decays, that in the dry, open air it does not accumulate, but is in great part carried away by the wind. It is only in swamps and shallow bodies of water that the decaying wood can gather in beds. From these facts we have a right to draw conclusions as to the former nature of the surface where there are no coal-beds. There are extensive beds of limestone in the western United States which are of the same age as the coal-beds in the east. As such beds of limestone could have formed only in the ocean, their presence throws a good deal of light upon the geography of those distant times.

Upon the Pacific slope the marshes were not so extensive, nor did they last for so long a period, as those in the East. Nature seems to have confined her strongest efforts at coal-making to the country east of the Rocky Mountains. Perhaps she thought that the people of the West would not need coal if she gave them plenty of gold and silver.

In the Appalachian mountains Nature folded the strata and left them in such a position that the coal could be mined easily. In the Mississippi Valley the beds were left flat, almost in their original position, so that shafts had to be sunk to reach the coal. Upon the Pacific slope Nature seems to have had a large amount of trouble in arranging things satisfactorily. She has made and remade the mountains so many times, and folded and broken the crust of the earth so severely where the swamps stood, that now large portions of the coal beds which once existed have crumbled and been washed away by the streams.

The scanty supply of coal which now remains is in most places hard to find and difficult to mine.

The best coal mined near the Pacific comes from Vancouver Island. Large beds of a younger and poorer coal are found southeast of Puget Sound. There are other

FIG. 108. — SEAMS OF COAL ENCLOSED IN SANDSTONE, CALIFORNIA

beds in the Coast ranges of western Oregon, and a few small ones in the Coast ranges of California. The great interior region between the Rocky Mountains and the Coast ranges has very little coal. The people of California have to import large quantities of coal. Some is brought by the railroads from the Rocky Mountain region, but the most comes by ships from various parts of the world, from England, Australia, or British Columbia. The ships bring the coal at low rates and take away grain and lumber.

Coal is almost the only important mineral which Nature has bestowed sparingly upon the Pacific slope. In California, however, she has made amends by storing up large quantities of petroleum. In Pennsylvania and Ohio there is petroleum as well as coal. Oil has also been discovered in the Rocky Mountain region and in Texas.

FIG. 109. — A SPRING OF WATER AND PETROLEUM
The black streak is petroleum

Petroleum is found flowing from the rocks in the form of springs, either by itself or associated with gases and strong-smelling mineral water. The oil is usually obtained by boring wells, but in southern California there is one mountain range which furnishes large quantities through tunnels which have been run into its side. Petroleum is commonly found in porous sandstones or shales, from one or two hundred to three thousand feet below the surface. It was

not made in these rocks, but has soaked into them just as water soaks into a brick. The rocks which produced the oil or petroleum are dark, strong-smelling shales or limestone. Heat a piece of such rock, and you will drive out a little oil.

Examine a piece of the shale from one of the oil districts of California, and you will discover that it is a very

FIG. 110. — OIL WELLS IN THE CITY OF LOS ANGELES, CALIFORNIA
Pool of oil in foreground

peculiar rock, for it is made up almost wholly of minute organisms which once inhabited the ocean. Among the forms which you will find are the silicious skeletons of diatoms, the calcareous skeletons of foraminifera, scales of fish, and, rarely, the whole skeleton of a fish.

Where now there are mountains and valleys dotted with oil derricks, there was once the water of the open ocean.

This water was filled, as the water of the ocean is to-day, with an infinite number of living things. As these creatures died, their bodies sank to the bottom, and while the soft parts dissolved, the hard parts or skeletons remained. Through perhaps hundreds of thousands of years, the skeletons continued to accumulate until beds were formed hundreds or even thousands of feet in thickness. The materials of the beds, at first a soft mass like the ooze which the dredger brings up from the bottom of the present ocean, became packed together in a solid mass.

Then disturbances affected this old sea bottom. It was raised, and gravel, clay, and sand from some new shore were washed over the bed of animal remains, burying it deeply. Continued movements of the earth finally folded these rocks, which, as they were squeezed and broken, became warm. The heat and pressure started chemical action in the decayed animal bodies, and particles of organic matter were driven off in the form of oil and gas. These substances were forced here and there through the fissures in the rocks. Part of the products found a way to the surface and formed springs, while other portions collected to form vast reservoirs in such porous rocks as sandstone. The sulphur and mineral springs which occur in oil regions tell us that this work of oil-making is still going on.

The oil as it comes from the ground is usually brownish or greenish in color, and much thicker than the refined product which we use in our lamps. Some of the crude petroleum is thick and tar-like in appearance, and when long exposed to the air turns to a solid black mass called "asphaltum." This, when softened by heat and mixed with sand, makes a valuable material for street pavement.

THE CLIMATE OF THE PACIFIC SLOPE

The western portion of the United States exhibits very interesting climatic features. In California, for example, there may be found every degree of temperature between tropic heat and arctic cold. In the deserts of the southeastern portion of the state the air is extremely dry, while in the northwest it rains nearly every month in the year.

Upon the borders of Puget Sound the thermometer seldom falls below the freezing-point, while southern Newfoundland, in the same latitude, is marked by cold and snowy weather for at least six months of every year. Southern California has the same latitude as central Georgia, but its average temperature near the coast is but little higher than that of Puget Sound, while it is warmer in winter and cooler in summer than Georgia. The deserts of southern California and Arizona are so hot that for four months of the year work in the sun is almost impossible; yet the higher portions of the Sierra Nevada mountains, but a short distance away, have an arctic climate. The whole Pacific coast region has, with the exception of the mountains, a much milder climate than one would expect from a mere knowledge of its latitude. It will be instructive to search out the reasons for the remarkable contrasts in climate presented by different portions of the slope.

The imaginary lines passing through points of equal temperature upon the earth are called "isotherms." These

lines rarely accord in direction with the parallels of latitude, but curve far to the north or south. The irregular course of the isotherms is due to many causes. Among these are the distribution of the land and water, the direction of the prevailing wind, the position of the mountain ranges, and the elevation above sea-level.

In winter the isotherms curve far to the north over the North Pacific and North Atlantic oceans; but over the intervening land they curve as much to the south. In

WEATHER MAPS

Fair weather over central portion of Pacific slope. Storm coming in upon coast of Washington

Stormy weather over the western half of the United States

summer the isotherms are almost reversed in position, at least as far as the land is concerned, for they bend to the north in the heart of the continent. There are important reasons for the slight variation of the isothermal lines upon the western borders of North America and Europe, and their great change of position in the interior from winter to summer, but these reasons are not at all difficult to understand.

The temperature of large bodies of water changes but

little throughout the year, for water warms and cools slowly. The surface of the land, on the contrary, heats rapidly, and then as quickly loses its heat with the changing season. The air over the ocean is cooler in summer and warmer in winter because of the influence of the water, but over the land, in districts far from a large body of water, the changes in temperature between day and night, summer and winter, are very great.

It was formerly thought that the warm Japan current, which flows against the western shore of North America, was responsible for the exceptionally mild climate there, and that the Gulf Stream produced a similar climate upon the coast of western Europe. More careful study, however, has shown that not the warm ocean currents, but rather the winds blowing from the water, are the cause of the mild climate in those lands across which they blow. In temperate latitudes there is a slow movement of the air in an easterly direction, and in consequence the climate of the western coast of North America is not marked by such extremes in winter and summer as are the interior and the eastern sections. It is also surprising to find how nearly alike the average winter and summer temperature is at San Francisco. It is also surprising to note that the average temperature of Seattle differs so little from that of San Diego, although these two places are separated by sixteen degrees of latitude.

In some places the climatic conditions which we should naturally expect seem to be reversed. Oranges are grown in the Great Valley of California as far north as Red Bluff, and actually ripen a month sooner than they do near Los Angeles, five hundred miles farther south. The early ripening of fruits in the Great Valley may be explained by

the presence of the inclosing mountain ranges: the Sierra Nevada mountains upon the northeast shut off the cold winds of winter, while the Coast ranges upon the west break the cool summer winds which come from off the Pacific.

Another interesting fact connected with the climate of the West is the influence exerted by the direction of the mountain ranges. As these ranges usually lie across the path of the prevailing winds, their tempering influence is lost much more quickly than it otherwise would be. West of the Coast ranges the summers are cool and the winters are warm. Upon the eastern side of these mountains the winters are somewhat cooler and the summers very much warmer. In the dry, clear air of the desert valleys, far from the ocean, the daily range in temperature is sometimes as great as fifty degrees, while the winters are cool and the summers unbearably hot.

We all know how much cooler a hill-top is than a valley upon a summer day. Where the mountains rise abruptly to a great height, as, for example, does the San Bernardino Range of southern California, one can stand among stunted plants of an arctic climate and look down upon orange orchards where frost rarely forms. Mount Tamalpais, a peak of the Coast Range north of San Francisco, has an elevation of nearly three thousand feet. The summer temperature upon this mountain forms an exception to the general rule, for while the lowlands are buried in chilling fog, the air upon the summit is warm and pleasant.

The north and south mountain ranges not only make the interior hotter than it would otherwise be, but rob it of much of the moisture which it should receive. The winter storms coming in from the ocean find the cool mountains lying across their path and quickly part with a large pro-

portion of their moisture. Where the coast mountains are low, as is the case with a great part of California and of Oregon, more of the moisture passes on to the next line of mountains, the Sierra Nevada-Cascade Range, the western slope of which is well watered. In the region of

FIG. 111. — ORANGE ORCHARDS CLOSE UNDER SNOW-CAPPED PEAKS
Highlands, California

the Columbia the Cascade Range is also low, and the storms, which often follow one another in quick succession, sweep across the Columbia plateau and over the Rocky Mountains. Farther south, not only are the storms fewer in number, but the mountains are very much higher, so that the desert basins of the lower Colorado and Death Valley region are extremely dry. One can in imagination stand upon the summit of the Sierra Nevada mountains, and upon the one hand look down upon barren valleys of vast

extent, broken by mountains almost as barren, where nothing can be grown except by means of irrigation; and upon the other side, toward the coast, see a country plentifully visited by rain, and either covered with forests or given over to farming and fruit-raising.

The Rocky Mountains form the eastern barrier which the storms encounter. Their summits are very high and are covered with deep snow during the winter. East of these mountains lie the Great Plains, where the precipitation is light until we go far enough toward the Mississippi Valley to reach the influence of the moist air currents from the Gulf of Mexico. Many storms originate over the region of the Gulf of California, particularly in the late summer, and supplement to some extent the light winter storms of Arizona and New Mexico.

The storms of which we have been speaking are known as cyclones. This term does not refer to the local storms which occur in the Mississippi Valley and are frequently so destructive, but to great disturbances of the air. Sometimes the column of whirling air is more than a thousand miles in diameter. The air in a cyclone is circling and at the same time rising, so that the motion is spiral. If you will study an eddy in a stream of water, you will get an idea of the nature of the motion, except that in the case of the water eddy the movement is downward. The motion of the particles in the dust-whirls which all have seen moving across the fields near noon on warm summer days illustrate the movement of the air in one of these great storms. The direction of the air in a cyclone is opposite to that of the hands of a clock.

When the wind comes up from a southerly point, when high, thin clouds, gradually growing thicker, spread over

the sky, and the barometer begins to fall, then it is known that a storm is coming. If one will learn to watch the clouds and the winds carefully he may become able to predict a storm with almost as much certainty as if he had a barometer. This instrument registers the pressure of the air, which is always less within the area of a storm, because then the air is rising. So when the barometer falls we may always know that a storm is approaching.

The greater number of the storms which occur in the central and northern United States come in from the Pacific Ocean in the latitude of Washington. Continuing east or southeast they reach the Mississippi Valley, and then turn northeastward toward the St. Lawrence Valley. In the summer months there are few storms, and they very rarely reach as far south as California. As winter approaches the storms become more frequent and severe, and move farther and farther south until the whole land as far as Mexico receives a wetting.

Upon the Pacific coast there is often very little warning of the coming of a storm, but in the Middle and Eastern States they may frequently be predicted several days in advance. With the passing of one of these storms the temperature falls rapidly, and this lowering of temperature, together with the fierce wind, gives rise upon the Great Plains to "blizzards" or "northers." These storms endanger the lives of both men and animals.

At different times in the year, particularly in winter, spring, and early summer, warm, dry winds occur. Those winds which sweep down from the heights of the Rocky Mountains and quickly melt the snows are known as "chinooks." The hot north and east winds of California often do great damage to growing crops.

Now let us sum up briefly the factors which have together produced the climatic features of the Pacific slope.

(1) Ordinarily the factor of the greatest importance is latitude. We should expect that Seattle would have a much colder climate than San Diego because it receives the sun's rays more slantingly.

(2) The influence of latitude is greatly modified by the temperate winds blowing from the Pacific, so that places far separated in latitude differ but little in average temperature, their summers being cooler and their winters warmer than we should expect them to be.

(3) The storms pass over the land with the general easterly movement of the air. The largest number pass east across the northern portion of the United States. The farther south we go the fewer are the storms and the less the rainfall. Along the coast of Washington the annual rainfall is nearly one hundred inches. At San Diego it is only about ten inches.

(4) The position of the mountain ranges causes the influence of the ocean on the air to be lost within a short distance toward the interior of the continent, so that the extremes of temperature rapidly become greater. The position of the mountains also affects the rainfall of the interior. Since a large proportion of the moisture is condensed upon their ocean slopes, the climate of each succeeding range toward the interior becomes more dry and desert-like. While in some of the lowlands thus cut off from the ocean the climate is extremely arid, yet the country is relieved from utter barrenness through the presence of mountain peaks and ranges, which often condense considerable moisture.

(5) The higher a region is above the sea, the colder

FIG. 112. — SCENE IN FORESTS OF WASHINGTON
Showing spruce and cedar.

the climate. The summit of a high mountain and the valley at its base may be in the same latitude, and yet one may possess an arctic climate while the other has a sub-tropical one.

The heavy rainfall in western Washington, Oregon, and northern California results in dense forests. To the south, the rainfall upon the lowlands is not sufficient to produce forests, but as it is greater upon the mountains, trees thrive upon their sides. The elevation at which trees will grow becomes higher and higher as we go into the more desert regions, until in northern Arizona it is found to be above six thousand feet. The high plateaus are generally treeless, but are covered with such shrubs as greasewood and sage-brush.

We see now that our climate is the product of many factors. It frequently varies greatly in places only a few miles distant from each other. Consequently there may be a great variety of productions and industries in one small area, while in other regions the climate and productions are almost unchanged for hundreds of miles.

SOMETHING ABOUT IRRIGATION

Travellers from the Eastern States who visit New Mexico for the first time are attracted by many unusual sights. There are the interesting little donkeys, the low adobe houses of the native Mexicans, and the water ditches winding through the gardens and fields, which are divided into squares by low ridges of earth.

If the fields are seen in the winter time, when dry and barren, the meaning of their checkered appearance is not at first clear, but in the spring and summer one is not long in finding out all about them. When the time comes to sow the seed, water is turned into these squares from the ditches which traverse the valleys, and one square at a time is filled until the ground in each is thoroughly soaked. Afterward, when the ground has dried enough to be easily worked, the crop is put in. The seeds soon sprout under the influence of the warm sun, and the land becomes green with growing plants. The same method of moistening the ground is used for the orchards and vineyards.

What is the use of all this work? Why not wait for the rains to come and wet the earth, as the farmer does in the eastern United States? The Mexicans, who have tilled these valleys for more than two hundred years, ought certainly to have learned in all that time how to get the best returns. You may be sure that they would not water the ground in this way if it were not necessary. The fact is,

that over a large portion of the western half of the United States it does not rain enough to enable the farmer to grow his crops. The climate is generally very different from that of the Middle and Eastern States.

When the Mexicans moved northward into the valley of the Rio Grande River, into Arizona and California, they found a climate similar in many respects to that at home, and soon learned that it was necessary to water the land artificially in order to make it productive. Though in many places sufficient rain fell, yet the heaviest rainfall came in the late summer or winter, when the plants needed it less, while the spring and summer were long and dry. The Mexicans were not the first to practise watering the land, if we may judge from the ruins of ancient ditches constructed by the primitive Indian inhabitants. It is evident that they too made use of water in this manner for the growing of their corn and squashes.

This turning of water upon the land to make it productive is termed "irrigation." The work is performed in different ways, as we shall see later. Irrigation is now carried on through all portions of the United States where the rainfall is light and streams of water are available.

To one who has lived in a country where there is plenty of rain, it seems to involve a great deal of work to prepare the land and to conduct water to it. One may feel pity for the farmer who has to support himself in this manner in so barren a country. I am sure, however, that if any such person will stop to think, he will remember times when in his own fertile home the expected rain did not come, and the vegetation wilted and dried up. He may have become discouraged because of a number of "dry years," but probably never thought that he had the means at

hand to make up, at least in part, for the shortcomings of Nature, in sending too much rain one year, and another year too little.

It would doubtless have paid such a farmer many fold to have been prepared at the coming of a dry year to

FIG. 113. — WATER-WHEEL FOR LIFTING WATER FOR IRRIGATION, VIRGIN RIVER, SOUTHERN UTAH

turn the water from a neighboring stream over his lands. This process would have involved a good deal of labor; but how the plants would have rejoiced, and how abundantly they would have repaid him for the extra trouble!

The showers come without regard to the time when growing things need them most, but with irrigation the crops are independent of the weather. The farmer may be sure that, if he prepares the ground properly and sows the seed, the returns will be all that he can wish. In many

localities several crops may be raised in a year by this method where otherwise only one would grow.

Now let us see how the water is taken from the streams and what are the different methods employed to distribute it over the land. Almost every valley is traversed by a stream, great or small. It may be a river, with a large

FIG. 114.—GARDEN IRRIGATION, LAS CRUCES, NEW MEXICO

volume of water, or a creek which completely dries up during the long, rainless summers of the West.

In rare cases the stream may flow upon a built-up channel which is as high as the valley, but usually it is sunken below the level of the floor of the valley, and enclosed by banks of greater or less height. How is the water to be sent over the land? Where the current is swift you may sometimes see a slowly turning water-wheel, having at the ends of the spokes little cups, which dip up the water as

the wheel revolves and pour it into a flume that runs back over the land. At some places engines are used to pump the water from the stream and lift it to the desired height.

Generally, however, another method is employed: the water is taken out of the stream in an artificial channel dug in the earth. But in order to get the water at a suffi-

FIG. 115. — IRRIGATING AN ALFALFA FIELD, ARIZONA

cient height to make it flow over the fields, it is necessary to start a ditch or canal at a favorable point some distance up the stream, perhaps miles from the garden.

The ditch is made with a slope just sufficient for the water to flow. The slope must be less than that of the river from which the water is taken, so as to carry the stream, at last, high enough to cover the lands to be irrigated.

Visit almost any valley in the West where agriculture or fruit-growing is being carried on, and you will at once

notice the lines of the ditches, apparently level, as they wind around the hillsides. At convenient distances there are gates to let out the water for the orchards and fields.

The ground may be moistened in different ways. The first method is that employed by the Mexicans, who, if we except the Cliff Dwellers, were the first to introduce irrigation into our country. This consists in dividing the land into squares by embankments and allowing the water to flood each in succession. The method is known as irrigation by checks, and can be used conveniently only upon nearly level land.

In many orchards a series of shallow furrows is ploughed between the rows of trees, and the water is allowed to flow down these until the soil is thoroughly soaked. In alfalfa fields the water is often turned upon the upper end and permitted to work its way across until it reaches the lower edge, soaking the ground as it goes. The slopes must in every case be so gentle that the current will not be strong enough to carry away the soil.

Once in every two to four weeks throughout the spring and summer, the exact period depending upon the rapidity with which the ground dries, the wetting is repeated. If the soil is light the water must be turned on more often and a larger supply is required.

It frequently happens that the stream from which the water is taken so nearly dries up in the summer, when the water is most needed, that the cultivated lands suffer severely. During the winter little if any irrigation is necessary, but at that time the streams are so full that they frequently run over their banks and do great damage.

How to preserve the water thus going to waste and have it at hand for summer use has been an important problem in regions where every particle of water is valuable. Study

of the question has led to the examination of the streams with reference to the building of reservoirs to hold back the flood waters. A reservoir may be formed of a natural lake in the mountains in which the stream rises, by placing a dam across its outlet and so making it hold more water.

FIG. 116. — SWEETWATER RESERVOIR, NEAR SAN DIEGO, CALIFORNIA

If this cannot be done, a narrow place in the cañon of the stream is selected, above which there is a broad valley. At such a place the dam which is built across the cañon is held firmly in place by the walls of rock upon each side, and an artificial lake or reservoir is made. Ditches lead away from this reservoir, and by means of gates the water is supplied when and where it is needed.

The streams which furnish the water for irrigation in the arid region rise in mountains with steep rocky slopes,

and until the water issues from these mountains it is confined to cañons with bottoms of solid rock, so that no water is lost except by evaporation.

After the streams emerge from the cañons upon the long, gentle slopes of gravel and soil which lie all about the bases of the mountains, they begin immediately to sink into the porous material. They frequently disappear entirely before they have flowed many miles. Some of this water can be brought to the surface again by digging wells and constructing pumping plants, but the greater part is lost to the thirsty land.

To prevent the water from sinking into the gravel, ditches lined with cement are often made to carry it from the cañons to the points where it is needed. Sometimes iron pipes or wooden flumes are used in place of the ditches.

What a transformation irrigation makes in the dry and desert-like valleys of the West! Land which under Nature's treatment supports only a scanty growth of sagebrush or greasewood, and over which a few half-starved cattle have roamed, becomes, when irrigated, covered with green fields and neat homes, while sleek, well-fed herds graze upon the rich alfalfa. Ten acres of irrigated land will in many places support a family, where without irrigation a square mile would not have sufficed.

One might suppose that the soil of these naturally barren valleys was poor, but such is not the case. The ground did not lack plant food, but merely the water to make this food available. With plenty of water the most luxuriant vegetation is produced. The soil is, indeed, frequently richer than in well-watered regions, for a lavish supply of water carries away a portion of the plant food.

In some places, where the land is almost level and the soil is filled with large quantities of soluble materials, such as soda and salt, keeping the ground moist through irrigation brings these substances to the surface in such quantities as to injure and sometimes kill the vegetation. In order that such lands may be successfully cultivated, the salts have to be either neutralized or washed away.

FIG. 117. — IRRIGATING DITCH, NEAR PHŒNIX, ARIZONA

Many of the rivers of the West carry large quantities of silt in suspension, which fills the ditches and causes a great deal of trouble; but when the silt is deposited over the surface it adds continually to the richness of the land.

The full development of irrigation will mean a great increase in the population and wealth of all the Western States.

THE LOCATION OF THE CITIES OF THE PACIFIC SLOPE

This old earth has to be consulted upon every occasion. It is a silent partner in all our undertakings. We sometimes think that we come and go as we please, but a little thought convinces us that we are not really so free.

The traveller must take account of the slopes of the land. It is much easier for him to follow a valley and cross a mountain range through a low spot, although his course be very crooked, than it is to make a "bee line" for his destination. The farmer, in choosing his home and the kind of produce which he will raise, has to consult the soil and climate. He cannot expect to grow grain where the soil is poor and dry, or grow apples where the late spring frosts kill the buds. The miner knows that he cannot expect to find gold veins in the valleys, where the rocks are deeply covered by the soil, and so he turns his steps toward the mountains, where Nature has made his work easy by lifting up the rocks and exposing them to his view.

Routes of commerce and trade are governed by geographic, and to a certain extent by climatic, conditions. Shallow streams with rapids and waterfalls obstruct navigation. The absence of harbors along a given coast makes it difficult for ships to take and discharge cargoes. Railroads cannot be constructed unless long and expensive surveys have first been made to determine the route which Nature has made the easiest between two given points.

The character of the climate and geographic features of a given country determine whether it shall become noted for agricultural productions, mining industries, manufactures, or commerce. The locations of the cities and towns and the roads connecting them depend upon geographic conditions. There is not an occupation of any importance in which people engage at any particular place that is not dependent in large degree for its success upon the conditions which Nature has imposed upon that place.

A city will not grow up at a given point unless the geographic conditions are favorable. There must be some natural reason to induce people to gather in large numbers in one place. At one spot there are facilities for manufacturing, such as water-power and coal, and easy means of communication with other parts of the world. At another, the only reason for the growth of a city is the existence of rich mines. A third place may be conveniently located in the midst of a rich agricultural region, where it is easy to bring in supplies and ship out the products of the soil.

A study of the founding and growth of some of the cities of the West, and particularly of the Pacific slope, will bring out many interesting facts.

San Francisco is the metropolis of the Pacific; its population will soon reach half a million. If we look back seventy-five years we find San Francisco an unimportant Mexican military post and the seat of one of the smaller missions. Monterey, the capital of the province of California and one of the two leading towns (Los Angeles being the other), apparently had all the advantages in the race for supremacy.

In date of discovery (1603) Monterey Bay has the advan-

tage of more than one hundred and fifty years over San Francisco Bay. It is difficult to understand why the different navigators who sailed north along the coast failed to discover California's most magnificent bay. Sir Francis Drake went by it, evidently not seeing the narrow opening between the headlands now known as the Golden Gate. Vizcaino, after discovering Monterey Bay, also passed by and anchored where Drake had stopped, in a little bay now called Drake's Bay, a few miles north of San Francisco Bay.

After the founding of San Diego, in 1769, a party started overland for Monterey, but by reason of the peculiar position of the bay they passed it unknowingly, and by accident came upon the body of water which has since been of so great importance to the commercial life of California. Monterey Bay in time lost its importance, partly because it was not thoroughly protected from the storms, and partly from the lack of easy communication with the rest of the state.

Immediately after the acquisition of California and the discovery of gold, the advantages of San Francisco Bay began to be appreciated, and the little Mexican town grew rapidly. The narrow entrance to the bay, which had for so long a time delayed its discovery, completely protected it from the storms, while its long arms opened across the coast mountains directly into the important valleys of the interior. Ocean vessels could go up the bay and through the Strait of Carquinez, while river boats could be used for many miles farther. After the discovery of gold, ships from all parts of the world found ample room and shelter in San Francisco Bay; and the incoming miners, going by the water routes to Marysville, Sacramento,

and Stockton, easily reached the gold-bearing gravels of the Sierra Nevada streams.

With the exception of southern California and a portion of the northern coast, almost all the agricultural and mineral resources of California are directly tributary to San Francisco. This place is naturally the centre of home trade, of foreign commerce, and of population.

FIG. 118. — SAN FRANCISCO BAY

Formed by the sinking of the land and flooding of a river valley

Nature failed to supply San Francisco with one essential advantage, namely, cheap power for manufacturing. There is no water-power near and but little coal in the state. Since the coal has to be shipped in from distant points, its high price has impeded manufacturing. But now it appears that San Francisco is not so badly off after all, for important deposits of petroleum have been discovered in

the central and southern portions of California; and besides, processes have been invented for transforming the unlimited water-power of the mountain streams into electric energy, and transmitting this power to all the cities about the bay.

The early Spaniards founded the pueblo of Los Angeles in its present location, because at this point the Los Angeles River carried an abundance of pure water which could be led out in ditches to irrigate the fertile bottom lands in the vicinity. Partly because it became a railroad centre, and partly because it is surrounded by rich valleys, Los Angeles has grown with great rapidity and now stands next to San Francisco in size among California cities.

San Diego, which has a harbor next in importance to that of San Francisco, has grown more slowly, because of the greater difficulty in developing water systems for irrigation, and because access is not so easy on account of the enclosing mountains. However, it must in time become the second commercial city of the state.

Mountain barriers make travel from one portion of California to another somewhat difficult. Mountains separate San Francisco and the Great Valley of California from all other portions of the continent. Nature seems to have planned here a little empire all by itself. But engineering skill in the construction of railroads has overcome the barrier upon the north which separates California from Oregon. The Sierra Nevada range upon the east has been crossed at Donner Pass, and upon the south an outlet has been found through the Tehachapi Pass.

In the state of Oregon, the city of Portland ranks first in importance. Why did not Astoria or Fort Vancouver develop into the metropolis of the Columbia basin?

Astoria, which was founded in the early part of the last

century, has a spacious and well-protected harbor, but it has no large tributary agricultural valleys. Moreover, the greater number of deep-water ships pass it by, and go as far up the Columbia as possible to take on their loads of grain.

Fort Vancouver, on the site of the old Hudson Bay trading post, is practically at the head of deep-water navigation upon the Columbia, but there seems to be no particular reason why trade should centre here, and this town also has been left behind in the march of progress.

The earliest settlements in western Oregon were made upon the Willamette River, which drains a large and extremely fertile valley. Near the point at which this river joins the Columbia, the city of Portland sprang up. This town occupies an ideal position. It is accessible for deep sea vessels, and has communication by river boats with the Willamette Valley and the upper Columbia River.

In the eighteenth century, when sailors were looking for a passage across the northern portion of the continent, an opening was found extending into the land between Vancouver Island and Cape Flattery. It was at first thought that this was the desired waterway, but various navigators, among them Vancouver, explored the body of water into which the Strait of Fuca opened, only to find that every branch and inlet terminated in the land. Puget Sound is nearly enclosed by water and is so large as really to form an inland sea. Its long arms reach out in three directions among the most heavily timbered valleys and mountain slopes of the United States.

The cities of Puget Sound had a later start than most of the other cities of the Pacific coast, for this portion of the old Oregon territory was for a long time claimed by the

English, and during that period was peopled only by Indians and trappers. In 1846 the present boundary was established, and Puget Sound passed into the possession of the United States.

Because of the dense forests, agriculture could not play an important part in the development of the sound region for some time. Lumbering was naturally the leading occupation. This industry could be carried on all the more advantageously because of the innumerable inlets penetrating the land.

The advantages of Puget Sound for foreign commerce began to be evident, but the Cascade Range stood in the way of railroads from the eastward. Although it was a comparatively easy task to build a railroad north from Portland, yet the sound region did not begin to grow rapidly until, after careful surveys, two railroads finally found passes through the Cascade Range so as to reach tide-water. As in other places, when the necessity for overcoming them arose, the obstacles which Nature had interposed were found not to be so troublesome as was at first supposed. Now the once formidable range has been tunnelled and will no longer form a serious barrier between the interior portion of Washington and the coast.

Tacoma, Seattle, and Everett have grown up on the sound as important commercial and manufacturing cities, and will, on account of their favorable situation, receive their share of the commerce of the Pacific. The cities of the sound are particularly well situated for intercourse and commerce with Alaska and northeastern Asia.

These cities are also well situated for manufacturing, because coal and wood are plentiful and consequently cheap, but they have not in their immediate vicinity so ex-

tensive agricultural valleys as the Willamette and the Great Valley of California. The lumberman must be supplanted by the farmer and fruit-grower before the slopes about Puget Sound can be fully developed.

The natural outlet for the great wheat-fields of central Washington is by way of the Columbia River to the ocean, but the tunnelling of the Cascades partly diverts their products to the sound region.

FIG. 119. — FALLS OF SPOKANE RIVER

Location of the city of Spokane

The city of Spokane, in eastern Washington, clearly illustrates the control which physical features exert upon the settlements and industries of men. The Spokane River, soon after issuing from Cœur d'Alene Lake, flows out over the volcanic plains of Washington. In the course of a few miles it descends into a shallow cañon by a series of cascades and waterfalls. The water-power furnished by

these falls has determined the position and growth of Spokane. The falls brought sawmills and manufacturing plants, and these in turn brought people and railroads. The city has become a great commercial centre for all the region round about. The extensive and rich

FIG. 120. — VIRGINIA CITY, NEVADA
Supported entirely by mining

mineral district upon the north, extending even into British Columbia, finds its most convenient source of supplies at Spokane. East of the city is the Cœur d'Alene mining region, while south and west are large areas devoted to the cultivation of fruit and grain.

The city of Great Falls, Montana, in the Missouri River basin, is destined to become a great industrial centre, because of the presence of unlimited water-power afforded by the Great Falls of the Missouri River. No other reason would lead to the growth of a settlement at this

particular spot, for boundless plains extend about it in every direction.

The mining cities of the West, such as Butte, Virginia City, and Leadville, illustrate the growth of important centres of population in the vicinity of large deposits of

FIG. 121. — BUTTE, MONTANA
A city of smelters

minerals. In the case of these cities, as well as many others, there are no agricultural resources in the surrounding country to support the people gathered together here. Nearly all their food has to be shipped hundreds of miles. Cities supported by mining are less likely to be permanent than those supported by an agricultural community, by commerce, or by manufacturing.

THE FOREST BELT OF THE SIERRA NEVADA MOUNTAINS

No other coniferous forests in the world can compare with those covering the western slope of the Sierra Nevada and Cascade ranges. They are remarkable both for the number of species and for the size of the trees. The moderate temperature and the moist winds from the Pacific seem to offer the conditions which are best suited to the growth of cone-bearing trees.

As we go northward along the coast, or ascend the mountain slopes, we find the climate growing cooler and cooler. With this changing climate the species of conifers change, for each has become accustomed to certain conditions of temperature and moisture, which it must have in order to thrive.

The Sierra Nevada is the most continuous lofty range of mountains in North America. From the great valley at its western base to the crest of the range the distance is about sixty miles. Because of the great height of the mountains, there is found within these few miles every variety of climate between the sub-tropical atmosphere of the valley, where oranges ripen to perfection, and the arctic cold of the summits, where little or no vegetation can live.

Thus, by climbing a single mountain range, we may experience all kinds of climate, and have an opportunity to observe the different forms of plant life such as we could not otherwise obtain without a journey of several thousand miles.

Passing through the groves of valley oak, and beyond the orange orchards at the foot of the mountains, we reach the foot-hills and begin to ascend. Several species of oak are found upon the hillsides and in the valleys, while mingled with them in many places appear such shrubs as

FIG. 122.— FOREST BELT OF THE FOOT-HILLS, SIERRA NEVADA MOUNTAINS

the California lilac, chamiso, and manzanita. Where the soil is too poor or the slopes too steep for the trees, these shrubs, commonly called "chaparral," are massed together in almost impenetrable thickets.

The first of the coniferous trees which we meet is an odd-looking one known as the digger pine. Instead of having a single straight trunk it divides a short distance above the ground into many branches. The large cones

are armed with long hooked spines, so that they must be handled rather carefully, but when opened they are found to be filled with nutritious nuts. These nuts were an important source of food for the Indians who once inhabited the foot-hills. Now the Indians are gone, but the nuts are not wasted, if one may judge by the fragments of the cones with which the squirrels strew the ground.

FIG. 123. — THE DIGGER PINE

The road climbs the foot-hills by many turns and windings through cañons and up and down ridges. At an elevation of about two thousand feet specimens of the yellow pine appear. The trees increase in size and grow more closely together as we ascend. We soon find ourselves in the edge of the forest belt which extends unbroken northward to the arctic zone, and upward to the line of almost perpetual snow.

The yellow pine, so named from the color of the bark, sometimes attains a diameter of six feet, but does not form so dense forests as we shall find higher on the mountains. The rays of the warm sun, reaching down between the trees to the carpet of needles and "bear clover," draw

out their spicy fragrance. The yellow pine, although it does not afford as good a quality of lumber as some of the other pines, is one of our most important trees because of its wide distribution through nearly all mountains

FIG. 124. — A YELLOW PINE FOREST

of the West. It has a much wider range in elevation than most trees, one variety reaching upward nearly to the timber line.

After getting well into the yellow pine forest, we soon come upon other trees that contend with the pines for a footing upon the slopes and for a bit of the sunshine. Among these the black oaks deserve special mention, for in places they form dense groves upon the ridges. The

cedars, with their rich brown bark and flat, drooping branches, are easily recognized. As these trees grow old they become gnarled and knotty and very picturesque.

We first meet that "king of pines," the sugar pine, upon the more shaded mountain slopes. Although higher up, on barren, rocky ridges, this tree grows to noble size, yet it cannot withstand heat and dryness. Our attention may be first called to the sugar pine by the slender cones, ten to fifteen inches in length, which are scattered over the ground. Then, as we look up to see whence the cones come, our eyes light upon the smooth trunks, often over six feet in diameter and reaching up one hundred and fifty feet before the branches appear. From the ends of the long, drooping branches hang slender green cones. The name of this pine is derived from the fact that a white sugar gathers in little bunches at the spots where the trunk has been injured. This sugar is pleasant to the taste and somewhat medicinal.

FIG. 125. — SUGAR PINE

The wood of the sugar pine, which is white and fine-grained, is of greater value commercially than that of any of the other pines. This fact leads the shake-maker and

FIG. 126. — ZONE OF THE FIR FOREST, SIERRA NEVADA MOUNTAINS

lumberman to seek out the noble tree and mark it for destruction. The sugar pine, when once destroyed in a given locality, rarely replaces itself, as it is crowded out by the more vigorous conifers.

Scattered through the forests of yellow pine, cedar, and sugar pine is the Douglas spruce, commonly known in the market as the Oregon pine. This is the most important forest tree in Oregon and Washington. It often grows to a height of three hundred feet, and forms dense forests for hundreds of miles along the base and western slope of the Cascade Range. In Washington it is found growing down to the sea-level, but in the Sierra Nevada the requisite moisture for its growth is not found much below an elevation of four thousand feet.

As we go upward the pines become fewer and the firs and "Big Trees" take their places. The Big Trees are found in scattered groves, at an elevation of five thousand to eight thousand feet, for a distance of two hundred and fifty miles along the slopes of the Sierra Nevada mountains. The Sequoia, as the genus is called, which also includes the redwood of the Coast ranges, is in many respects the most remarkable of all our coniferous trees.

After travelling through forests made up of other trees of great size it is difficult at first to appreciate the magnitude of the Big Trees. Rising from a swelling base, which is sometimes thirty feet in diameter, the symmetrical trunk reaches up and up, finally terminating in a top three hundred to three hundred and fifty feet above the ground. Their size, their reddish-brown bark, and their small cones, clearly distinguish these trees. Great holes have been burned in many of them, and in the hollows thus formed men have made for themselves comfortable living rooms.

FIG. 127. — THE BIG TREE FOREST IN THE SIERRA NEVADA MOUNTAINS

In one of the southern groves a fallen hollow tree has been used as a cabin.

The Big Trees and redwoods are the last surviving species of a genus which was once widely distributed over the earth. The ancestry of the Sequoia can be traced farther back than that of any of the other living conifers. Impressions of cones and small stems with needles attached belonging to the Sequoia have been found in the oldest rocks of the Coast ranges of California. These cones and stems were washed into some muddy estuary and there buried, millions of years ago. The mud inclosing them was compressed and hardened, and finally changed to slate. This was at last exposed upon the surface through the uplifting of a mountain range and the work of erosion.

Some of the groves of the Big Trees have been included in government parks and reservations, but others are being cut as rapidly as possible by the lumbermen. The redwood of the Coast ranges is not easily killed, for it sprouts from the stump, and will in the course of time form forests again; but the Big Trees rarely replace themselves when a grove has been cut down. These trees are so few in number and of such remarkable interest that they should be spared the fate of the common forest tree.

It would make you feel sad to visit one of the groves and see, as I did, a fallen giant, fully thirty feet in diameter, lying split open upon the ground. This tree was so large that, in order that it might be handled at all, powder had to be used to blast it in pieces. The tree was knotty, and according to the lumbermen, of little value, and might as well have been left. What excuse is there for the wanton destruction of a noble tree like this one? It must have stood from five thousand to six thousand years. It

was a mighty tree at the beginning of the Christian era, and was growing, a strong tree, when our ancestors were the rudest savages in the wilds of Europe.

But we must not remain among the Big Trees, for the forests extend much farther up the mountains. The most important tree of the upper forest belt is the fir, which is found growing from five thousand to nearly nine thousand feet above sea-level. It is one of the most graceful of the conifers. Sometimes these trees reach a height of two hundred and fifty feet and form dense forests with little undergrowth. The branches make the soft, fragrant beds which so rest and delight the tired mountain climber. Here and there about the springs and at the heads of the streamlets the firs appear to stand back, making room for green meadows brightened with a profusion of flowers.

FIG. 128. — ALPINE HEMLOCKS

The tamarack, or lodge-pole pine, is sometimes found at about the same elevation as the firs, but seems to prefer the moist lands about the meadows and the bottoms of the narrow valleys. This tree is widely distributed at high altitudes all over our Western mountains.

Continuing our climb toward the alpine regions, we reach an elevation where the trees begin to show the effects of the winter storms. The fact that life is not so easy as it is farther down the slopes is apparent from the gnarled and stunted trunks. Here are the alpine hemlocks, dwarf pines, and junipers.

The juniper somewhat resembles the cedar, but has a short, thick trunk. Near the timber line this tree grows but a few feet high and becomes exceedingly gnarled. It seems to like the most exposed and rocky places, but in truth, like many another form of plant life, it has become accustomed to such locations because it cannot successfully compete with other trees in happier ones.

Most weird and picturesque of all are the dwarf white pines, growing upon the extensive mountain shoulders and ridges at a height of ten thousand to eleven thousand five hundred feet above the sea. Since an arctic climate surrounds them for nine months in the year, their growth is very slow. Their short, gnarled trunks and branches are twisted into all sorts of fantastic shapes. When, after struggling with the cold and the storms, the trees at last die, they do not quickly decay and fall, but continue to stand for many years.

These trees become smaller and smaller in size until at the extreme timber line they are almost prostrate upon the ground. In many cases they rise only three or four feet, and have the appearance of shrubs rather than trees. Still above them, however, there are rocky slopes and snow-banks reaching to an elevation of over fourteen thousand feet. If we examine these upper slopes carefully we shall find that they are not utterly devoid of life, but that certain plants have been able to obtain a foothold upon

FIG. 129.—THE UPPER LIMIT OF THE TIMBER
Sierra Nevada Mountains

them. In sheltered nooks there are little shrubs and lichens. In some places among the rocks, beneath overhanging snow-banks, beautiful flowers spring up at the coming of the late summer, blossom, mature their seeds, and die with the return of the winter cold.

The magnificent forests through which we have passed in our long climb, if destroyed by the lumberman, cannot be replaced for hundreds of years. They contribute much to the glory of the mountains. They hold back the water so that it does not run off rapidly, and thus aid in giving rise to innumerable clear, cold springs. The springs help feed the streams during the long, dry summers, when the water is so sorely needed in the hot valleys below.

THE NATIONAL PARKS AND FOREST RESERVES

The people who first pushed into the unknown country west of the Mississippi, in the earlier half of the last century, were chiefly hunters and trappers. They did not intend to make permanent homes in the wilds, but rather to stay only so long as they could secure an abundance of fur-bearing animals.

Then came the discovery of the precious metals, and thousands of gold-seekers crossed the plains, and spread out over the mountains of the Cordilleran region. They, too, expected to get rich by making use of the resources of the country, and return to their homes in the East.

At the present time the destruction of our forests and serious injury to the water supply has been threatened through the organization of large lumber companies. Those interested in lumbering usually live far removed from the scenes of their operations, and consequently care little about the condition in which the deforested lands are left.

The farmers were the first permanent occupants of the West. Unlike the wandering trappers and miners, they established homes and made the land richer instead of poorer. As long as the population was scanty there was not much danger of exterminating the wild animals, and the demands for timber were small.

Our forefathers who settled the Eastern states had to contend with the forests. Nearly every acre of ground

had to be laboriously cleared before anything could be planted. It was only natural that they should come to regard the forests as a hindrance rather than a blessing.

As the settlers spread westward to the prairies and plains they came upon a region almost destitute of forests; but still farther, in the mountains of the continental divide and the Pacific slope, they again found extensive forests. To them it seemed impossible that these forests could ever be exhausted, and therefore little care was taken for their preservation.

As the population increased, more and more lumber was needed for building purposes. Before the sawmill came split lumber was used, and the shake-maker did not hesitate to cut down the largest and most valuable pines on the mere possibility that fifteen or twenty feet of the butt would split well enough to make shakes. It made no difference to him that the whole trunk rotted upon the ground.

When the sawmills were built and there came a demand from abroad for lumber, the forests were attacked upon a much larger scale. The need of the moment was all that concerned the lumbermen, and they took no care for the preservation of the young trees, which in time would have renewed the supply. The litter of the trunks and branches which they left upon the ground furnished fuel for the fires which frequently swept over these areas and killed the remaining growth.

As a result of these fires, the few animals that have escaped the hunters have been killed or driven from their homes, and the forest cover, which would retain much of the moisture and preserve it for the supply of the streams in summer, has been destroyed. The removal of the forest cover leads also to the washing away of the soil, the shoal-

ing of the streams, floods in spring, and low water in summer. In fact, all the people and industries of the region are affected by its loss. It may take hundreds of years for the country to recover; indeed, if the rainfall is light, the forests may never grow again, without artificial aid.

FIG. 130.—A BURNED FOREST, CASCADE RANGE, OREGON

The careless stockman, seeking to enlarge his pastures by burning the underbrush, sets fires which often destroy hundreds of square miles of forest. The summer camper and the prospector also frequently go on their way without extinguishing the camp fire, though a great forest fire may be the result.

Ours is a fertile and productive earth, capable of supporting a multitude of living things. For ages the lower animals, as well as savage man, lived under the protection

of Nature, making the best use of her products of which they were capable; but they never brought about the unnecessary, and often wanton, destruction of which we are guilty, — we, who call ourselves civilized. In killing the wild animals we cannot make the plea of necessity, as can

FIG. 131. — EROSION UPON AN UNPROTECTED SLOPE

savages who have no other means of support. Likewise, there is no necessity for killing the beautiful singing birds, merely for their plumage.

The forests are cut away without any thought of the retribution which Nature is sure to bring upon us. They are of vast importance to the well-being of the country and are the natural possession of all its people. We ought not to permit them to be destroyed indiscriminately for the benefit of a few. We need lumber for many purposes;

but a careful treatment of the forests with an eye to their continuance, the plan of cutting large trees, and preserving the small ones, is a very different thing from our present wasteful methods.

Every summer the air is filled with the smoke of burning forests, and the lumbermen are at work harder than ever felling virgin forests upon more and more remote mountain slopes.

Books of travel written fifty years ago tell of animal life in such abundance in many portions of the West that we can hardly believe their stories. A description of California written in 1848 mentions elk, antelope, and deer as abundant in the Great Valley. How many of us living at the present time have ever seen one of these animals in its native haunts?

There is hope now that this wasteful use of Nature's gifts will soon be stopped. Large areas of the mountainous portions of the public domain are being set aside as parks and forest reserves. The parks contain some of the finest scenery and most wonderful natural curiosities to be found upon the face of the whole earth. This wild scenery, together with the forests and plants of every kind, as well as the animals and birds that inhabit these areas, are to remain just as they were when the first white man looked upon them.

The parks form asylums for the wild creatures which have been hard pressed for so many years. In the Yellowstone National Park, where they have been protected the longest, the animals have almost lost their fear of man and act as if they knew that they are safe within its limits. In the Yellowstone you may see great herds of elk feeding in the rich meadows; deer stand by the roadside and

watch you pass, while the bears have become so tame about the hotels that they make themselves a nuisance. Sixteen bears at a time have been seen feeding at the garbage pile near the Grand Cañon hotel.

The forest reserves differ from the parks in that they are established for utility rather than for pleasure. The forests now existing are to be cared for by the government and to be wisely used when lumber is needed. Fires are to be avoided so far as possible, and burned areas are to be replanted with trees. Another object to be accomplished is the retention of the forests about the heads of the streams so as to preserve the summer water supply. The water runs off more slowly from a slope covered with vegetation than from a barren one, and therefore has more time to soak into the ground. This is a very important matter in all mountainous districts, particularly where the rainfall is light.

The Yellowstone National Park is situated upon the continental divide in northwestern Wyoming. It is largely a plateau, with an elevation of seven thousand to eight thousand feet above the level of the sea. The surface of the plateau is covered with forests, meadows, and lakes; but the region is particularly remarkable for the geysers and hot springs, and the Grand Cañon and falls of the Yellowstone River.

Bancroft Library

Springs dot the surface of many parts of the park. The hot water is continually bringing mineral substances, the chief of which is silica, from the depths of the earth and depositing them about the orifices of the springs. In this manner wonderful basins, terraces, and cones have been built up, while the rocks have been either reddened or bleached out and softened into a form of clay.

The park region must have been for a long period the seat of volcanic action, for nearly all the rocks are cooled lavas. While the heat has disappeared from the surface, it must still be very great below, if we may judge by the quantities of hot water continually issuing from the springs.

In many a subterranean cavern steam accumulates until its pressure becomes too great for the column of water occupying the channel that leads to the surface; then the water is suddenly and forcibly expelled, giving rise to a geyser eruption. When the pressure of the steam has become exhausted, the water sinks back into the earth, leaving the basin of the geyser nearly or quite empty until the steam has again collected. Each geyser has its own period of eruption and is generally very regular. One little geyser, known as the Economic, because it throws out but little water, spouts regularly about every five minutes. Other geysers are active at intervals of several hours, while some take several years to get ready for a new eruption and then spout whole rivers of boiling water. In the Upper Geyser Basin the effect is very impressive, particularly upon a cool morning. The clouds of steam and the throbbing or roaring geysers lend to the region a weird and unearthly aspect.

The Yellowstone Lake is a large body of water situated almost upon the continental divide. Before the cañon, or Great Falls, or even the Yellowstone River itself existed, the lake stood about one hundred and fifty feet higher than at present, and its water emptied into the Pacific Ocean instead of the Gulf of Mexico. The drainage was changed by the work of a small stream having its source in the volcanic plateau north of the lake. It deepened its channel and extended its head waters back

until they tapped the lake at a point where the rim of the basin was lowest, and so drew away its waters in the oppo-

FIG. 132. — ECONOMIC GEYSER, YELLOWSTONE PARK

site direction. The Yellowstone River, with its deep, wondrously colored cañon and grand waterfalls, is the result of this change.

To the south of Yellowstone Park, but included in one

of the forest reserves, are Jackson Lake and the Teton range. The Three Tetons, one of which reaches a height of over thirteen thousand feet, were evidently noted landmarks for the hunters and trappers in the early days, for you will find them mentioned in many of the narratives of those times. The precipitous range, with its crown of jagged peaks and the beautiful lake nestling at its base, presents a picture never to be forgotten.

Very different from the region which we have been studying is that embracing the Crater Lake, National Park, which is situated upon the summit of the Cascade Range in southern Oregon. Here occurred, not many thousand years ago, one of the strangest catastrophes which, so far as we know, has ever overtaken any portion of our earth.

Towering over the present basin of Crater Lake was a great volcano, reaching, probably, nearly three miles toward the sky. During the glacial period it stood there, its slopes white with snow, apparently as strong and firm as Shasta or Hood or Ranier. But for some reason the volcanic forces within this mountain, which has been called Mazama, awoke to renewed action. The interior of the mountain was melted, and the whole mass, unable to stand longer, fell in and was engulfed in the fiery, seething lava. This lava, instead of welling up and filling the crater and perhaps flowing out, was drawn down through the throat of the volcano into the earth, and left an enormous pit or crater where once the mountain stood.

After the floor of the crater cooled and hardened, small eruptions occurred within it and a new volcano grew up, but, though nearly three thousand feet high, it does not reach to the top of the encircling walls of the old crater, which are, on an average, nearly four thousand feet high.

Then the rains and melting snows formed a body of water in the crater, and the wonderful lake came into existence. No such sight is to be found elsewhere upon the earth. Within a circling rim of cliffs, from eight hundred to two thousand feet high and nearly vertical, lies

FIG. 133. — CRATER LAKE

From the top of the cliffs two thousand feet above. Upon the right is Wizard Island, a volcanic cone

the lake, rivalling the sky in the depth of its blue coloring. The height of its encircling cliffs and its five-mile expanse of blue water help to make the lake a spectacle grand beyond description. At the present time the volcanic fires appear to be entirely extinct.

Forests of fir and tamarack have spread over the once barren slopes of lava and pumice which extend back from the cliffs. In the hollows, after the lingering winter snows

have melted, there are grassy meadows dotted with flowers. It is many miles from the lake to any human habitation, and all the region about remains just as Nature left it. It was a happy thought to make another national park here.

We have already learned something of the grandeur of the Yosemite Valley and have seen how it came into exist-

FIG. 134. — THE PUNCH BOWL, YELLOWSTONE PARK

ence. The valley is owned and cared for as a public park by the state of California, but, with Hetch-Hetchy Valley, it is included in a larger park under the control of the general government. Within the boundaries of this national park, as in the case of the others described, the natural features of the landscape, the forests, and the animals, are to be left forever undisturbed. The Yosemite Valley, although situated in the heart of the rugged Sierras, is reached by several good wagon roads and many more people visit it than go to Crater Lake, although the latter is fully as interesting.

FIG. 135.—THE FALLS OF THE YELLOWSTONE, YELLOWSTONE CAÑON

About a hundred miles south of the Yosemite is the General Grant National Park. This park is of comparatively small size, but contains a group of some of the largest and finest Big Trees in the country. Still farther south there is a reserve called the Sequoia Park, which contains the largest remaining groves of the Big Trees.

There are also many state parks scattered over different parts of the Union. The establishment of these parks is intended to preserve either the forests or natural scenery.

The retention by the state or general government of large tracts of mountain and timber land, and of those areas which are particularly interesting on account of their natural scenery, is of the greatest importance. The timber and water are preserved for the general good instead of being squandered for the enrichment of individuals.

The preservation of scenic features in their original wild state is just and right, because such things add to the pleasure of out-of-door life, elevate men's feelings, and cultivate a love for the beautiful. The protection afforded the plant and animal life by these reserves gives a better opportunity for studying them, and tends to foster a general interest in the welfare of living things.